INJURIOUS INSECTS
AND
THE USE OF INSECTICIDES
By
Frank W. Sempers.

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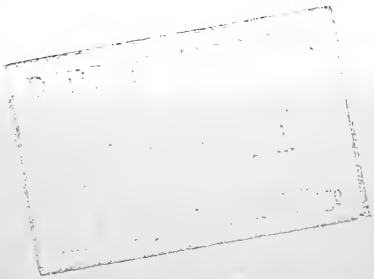
SEMPERS.



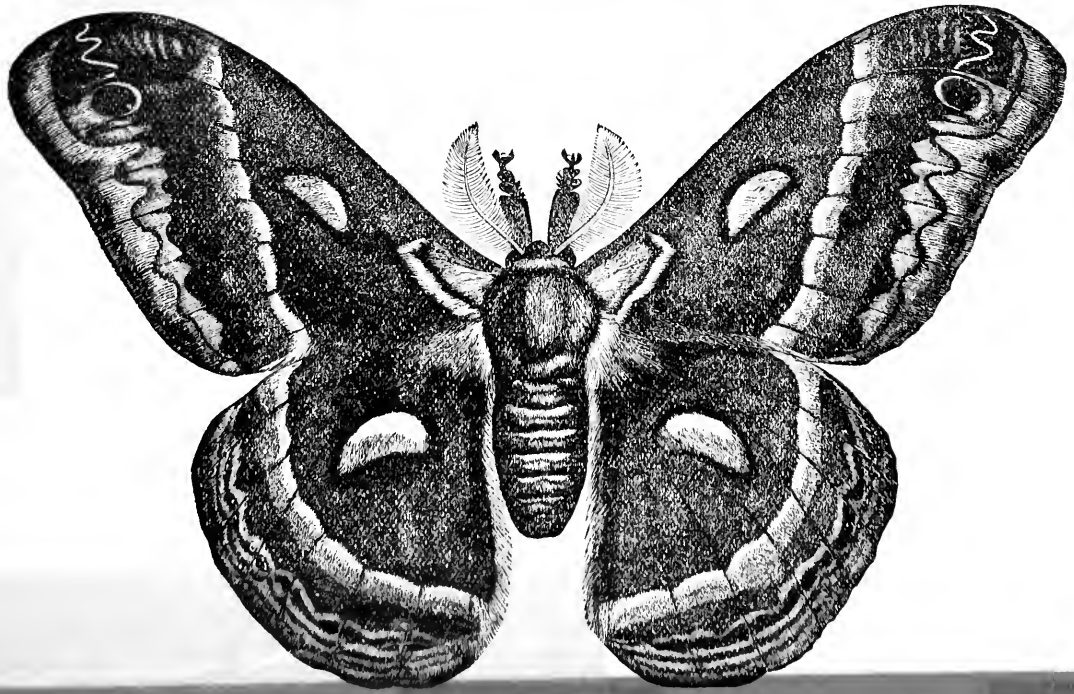


PLATE I.—Cecropia Emperor Moth. (*See Page* 99.)

INJURIOUS INSECTS

AND

THE USE OF INSECTICIDES.

A NEW DESCRIPTIVE MANUAL ON NOXIOUS INSECTS, WITH METHODS FOR THEIR REPRESSION.

BY

FRANK W. SEMPERS,

DIRECTOR OF FORDHOOK CHEMICAL LABORATORY; AUTHOR OF "MANURES: HOW TO MAKE AND HOW TO USE THEM."

WITH ONE HUNDRED AND EIGHTY-FIVE ILLUSTRATIONS.

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PREFACE.

Within a few years great changes have taken place in the methods of dealing with destructive insects. The rapid advances made in the science of economic entomology, the introduction of several highly efficient insecticides and the invention of labor-saving mechanical appliances for use in spraying, have done much to awaken farmers to the needs of broader knowledge and more scientific methods in combating noxious insects.

Scarcely twenty years ago the best farmers paid little attention to insect depredations. Such losses were regarded as of no significance, or as a part of the ordinary risks of farming. They were looked upon as occasional but inevitable evils which it was nobody's business to try to prevent. In the early *Seventies* when Dr. Riley and a few other scientists were laboring to overcome popular prejudice against the use of Paris green, in fighting the Colorado Potato-beetle, agriculturists, as a class, were indifferent and inactive until brought to their senses by serious losses or by the complete destruction of crops. But we have learned better since those times. To-day it is only the thriftless farmer who insists on growing crops to be eaten up by insects.

Such men, however, are by no means so rare as they should be. They are usually of that class to whom farming is a "*poor business,*" who cling tenaciously to old practice, or rather to no practice at all, and by converting their farms into breeding grounds for pestiferous insects are a menace to the prosperity of their neighbors and a nuisance in the community. Such culpable indifference to the rights of others is inexcusable, and it is to be hoped that, with the diffusion of knowledge and the growth of larger ideas, popular sentiment will crystallize into legislation for the repression of this evil.

There was a time when savage rites were paid to pagan gods for deliverance from insect visitations, and in less barbarous ages the priestly orders excommunicated insects as the enemies of God and man. This, old chroniclers tell us, was done in mediæval Europe, but with

what results the historians of those evil times have failed to record. Perhaps the farmers of to-day, who ignore the winged and underground enemies of their crops, might have fared better in those old times, but, in these closing years of the Nineteenth Century, there is no hope for them. They belong not to the present, but to the past, and to a system of agriculture doomed to irreparable failure. In this transitional period we must keep moving forward, welcoming without skepticism the discoveries of science, and applying them practically to the economies of life.

Happily, this is largely the case in America in everything that affects the profession of agriculture. The old order is rapidly changing, and between extremes of broad distinction and no distinction at all, we have a large and ever increasing body of practical men, anxious to reduce to practice the teachings of science.

From every quarter comes earnest inquiry for the latest knowledge and the best practice in dealing with insect depredators. And it is for this progressive, inquiring element among farmers and fruit growers that this volume has been written. No attempt is made to teach the science of entomology. In a work of such limited dimensions only the more common and more destructive injurious insects could be considered, and, necessarily, descriptions have been confined to a concise summary of characteristics, especially to those salient points in form, habits and life history, which may be serviceable in identifying destructive species and in counteracting their injuries. Descriptions wherever possible, are from personal observations, but free use has been made of the writings of our most eminent entomologists. Especially am I indebted to the researches of Dr. Chas. V. Riley, Entomologist of the United States, to the writings of Professors Cook, Comstock, Garman, Forbes, Fletcher, Fernald, Lintner, Osborn, Weed, Webster and others. The publications of the Division of Entomology of the United States Department of Agriculture and the popular Bulletins of many State Experiment Stations have contributed much valuable material to the book.

The illustrations have been gathered from many sources, and an effort has been made to have these accurate and life-like, since it is from good illustrations that the farmer most readily recognizes species under discussion. A large number of the illustrations are from copyrights belonging to Dr. Riley and are used by arrrangement with him.

Following are the illustrations after Riley, Figs. 6, 7, 29, 38, 41, 42, 43, 44, 48, 49, 50, 51, 52, 53, 54, 55, 57, 58, 65, 68, 73, 76, 77, 78,

82, 83, 84, 85, 93, 94–98, 101–103, 105, 107–112, 117, 118, 121–124, 129, 131, 132, 135–137, 143, 144, 154–160, and 183.

Figures 5, 8–15, 19, 21, 28, 30, 32–34, 39, 66, 120, 138, 145, 148, 149, 161, 162, and 184, were kindly loaned by Professor Otto Lugger, of the University of Minnesota; Figs. 16, 20, 25, 26, 63, 64, 74, 130, 133, 134, 141, 142, 150–152, and 173, were loaned by Professor H. Garman, Entomologist of the Kentucky Agricultural Experiment Station; Figs. 4, 79, 80, 99, 100, and Plate I, were loaned by Professor F. M. Webster, of the Ohio Agricultural College; Figs. 106, 125, and 180, by Professor J. H. Comstock, of Cornell University Agricultural Experiment Station; Figs. 91 and 92, by Professor J. B. Smith, Entomologist of the New Jersey Agricultural College; Figs. 67, 86, 113–116, 126, and 172 by Professor Clarence M. Weed, of the New Hampshire Agricultural College; Figs. 45, 46, 59–61, 87–90, by Mr. Mark Vernon Slingerland, Assistant Entomologist, Cornell University Experiment Station; Figs. 27, 178, 178, and 181, are after Osborn, and were kindly loaned by the officers of the Division of Entomology, United States Department of Agriculture; Figs. 2, 3, and 70, are after Glover; Fig. 164, from block belonging to the Division of Entomology, was loaned by Professor M. H. Beckwith, of Delaware College Agricultural Experiment Station; Figs. 17, 18, and 147, are after Miss Ormerod; Fig. 40, after Harris; Figs. 35–37, were loaned by Mr. Thomas Woodason, of Philadelphia, and Fig. 31 by Mr. W. C. Barnard, of Worcester, Mass.

In addition to the eminent entomologists, whose illustrations appear throughout these pages, I would acknowledge my obligations to Mr. L. O. Howard, Assistant Entomologist of the United States Department of Agriculture, and to Mr. Geo. Marx, Chief of the Division of Illustrations of the Department of Agriculture; also, to Dr. Edw. J. Nolan, Librarian of the Philadelphia Academy of the Natural Sciences, for courtesies extended to me while engaged in the prosecution of the work.

F. W. S.

FORDHOOK FARM, *January, 1894.*

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INJURIOUS INSECTS

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PART I.

INSECTS, CLASSIFICATIONS, AND INSECTICIDES.

INTRODUCTION.

The annual loss to the people of the United States due to the depredations of noxious insects, is placed by the very conservative estimates of Professor James Fletcher, the Dominion Entomologist, at $380,000,000.

In his inaugural address, delivered before the third annual meeting of the Association of Economic Entomologists, held at Washington, D. C., Professor Fletcher made the following remarkable statement :— "The amount of damage done to crops each year is so vast that the figures excite incredulity from those who do not study crop statistics. The agricultural products of the United States are estimated at about $3,800,000,000. Of this it is thought that about one-tenth is lost by the ravages of insects. In short a sum of $380,000,000 is given up without a murmur, and almost without a struggle by the people of the United States."

Notwithstanding the fact that many natural and artificial causes operate to check the increase of insects, the enormous losses due to their depredations become more burdensome from year to year.

The marvelous fecundity characteristic of insect life, the constantly increasing area of cultivation, the favorable conditions of existence in a land undergoing great agricultural development, and the facility with

which the eggs and larvæ are transported from place to place in interstate commerce, together with many minor causes, all aid in spreading destructive species and in augmenting their numbers.

In this little book our design is not the systematic study of the science of Entomology—our object is to observe the habits and life history of injurious insects, for the purpose of preventing their extension and damage. We shall make no attempt to describe scientifically the numerous pests of the farm and garden, but shall confine descriptions to those distinguishing characteristics, in form, color, habits, methods

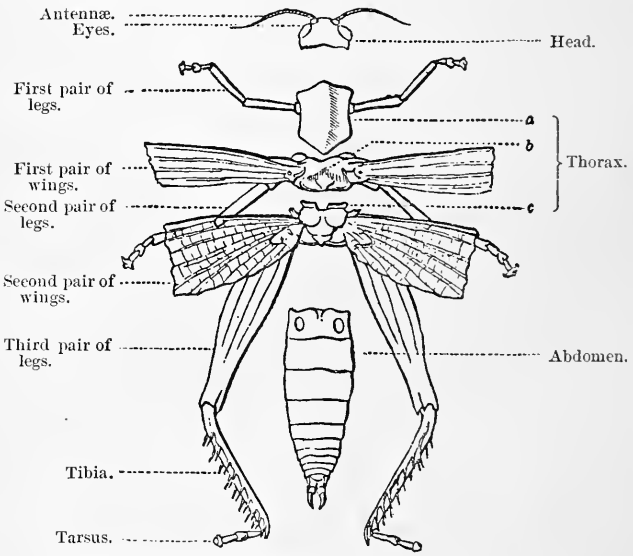


FIG. 1.—DISSECTED "GRASSHOPPER," SHOWING DIVISIONS OF BODY.

of increase and transformations, which may be of service to the farmer in identifying his enemies and in compassing their destruction.

Insects are distinguished from some nearly related articulates or jointed animals by having in their adult or perfect stage three pairs of legs and generally wings: their external skeletons appear to be composed of thirteen joints or rings which are grouped into three regions known as the *head*, *thorax*, and *abdomen* (See Fig. 1). It is from this peculiar structure of their bodies that the term *insect* is derived. The name is from two Latin words *in* and *seco*, to cut, meaning to cut into,

that is, insected or divided into rings. (1) The *head* contains the organs of vision, the antennæ or feelers, which are the chief organs of touch, hearing and smell; and the mouth or feeding apparatus, and the organs of taste. (2) The *thorax* contains the organs of locomotion —the legs and wings. (3) The *abdomen* contains the digestive and reproductive organs, and in many insects the organs of self-defense.

Most insects in the course of their development pass through four distinct stages of existence. The first of these is the *egg;* second, the *larva;* third, the *pupa chrysalis* or *nymph*; and fourth, the *imago* or perfect insect.

In the larva stage the immature insect is a voracious feeder. In

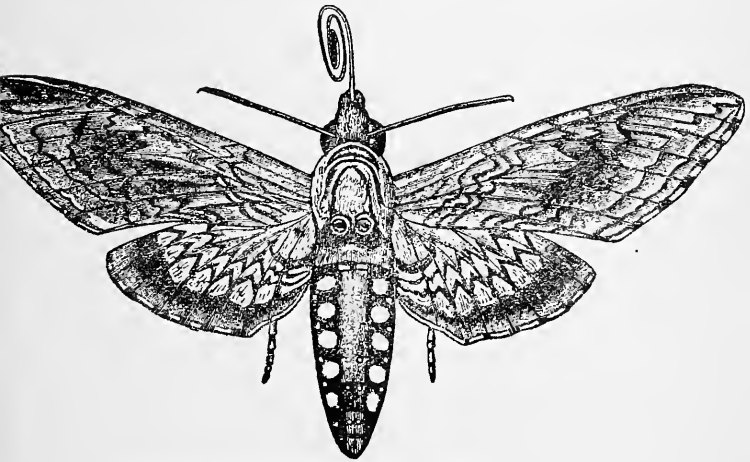


FIG. 2.—IMAGO OF PHLEGETHONTIUS CELEUS. (*Glover*)

popular language the larvæ (plural of larva) are generally, though incorrectly, called "*worms;*" other distinctive names are also given to this period of insect life; thus the larvæ of beetles are called *grubs* and *borers*, those of moths and butterflies are called caterpillars, or, if infesting the wood of trees, are very generally known as *borers;* and the larvæ of two-winged flies are called *maggots.*

The larva is the formative or growing stage of insect life. With many insects this is a short but hungry stage of existence, lasting from one to four weeks, but with some species the larval period extends over several years. During this stage of life is stored up all the

materials required to produce wings, the organs of reproduction and the materials for the transformations of the other organs of the body, such as legs, wings, eyes, etc., in the adult.

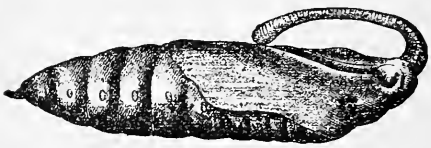


FIG. 3.—PUPA OF PHLEGETHONTIUS CELEUS. (*Glover.*)

After a usually short but hungry life the larva attains full growth, wraps itself in some sort of cocoon or cell and enters upon the pupa or quiescent stage of life. During this period the insect is usually in a dormant condition, or at least is apparently so. In reality most wonderful changes are going on within the seemingly lifeless pupal shell. All insects, however, do not spend the pupal stage in a quiescent state. Some remain active. The fact is, the metamorphoses or transformations of insects vary greatly, and, as we shall soon see, serve as a basis for their classification into two widely differing groups.

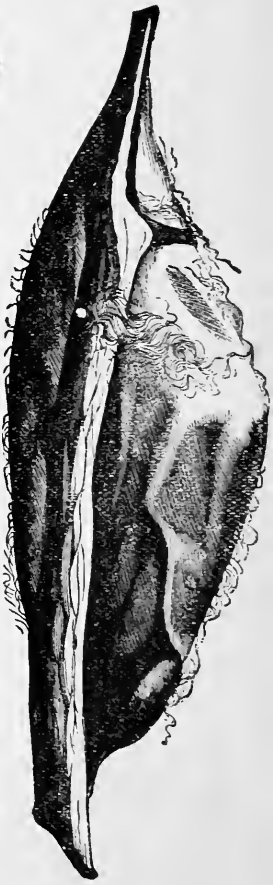


FIG. 4.—COCOON OF CECROPIA EMPEROR.

As the period of pupation, or of change from the larva to the pupa approaches, some insects spin a cocoon in which to pass the dormant pupal stage, some form about themselves a covering of leaves tightly drawn together, some are covered by a hard pupal casing, while others that descend into the earth, or that are subterranean in their habits during the larval period, hollow out cells in the earth in which the quiescent stage is passed. In due season come forth perfect insects, more wonderful in their metamorphoses than the transformations of the nymphs of Diana as told in mythic story.

The imago usually lives but a short time—but for a few days or a few weeks—just long enough to fulfil the one function of its life, which

FIG. 5.—LARGE SAW-FLY, LARVÆ, COCOON (*d*), AND ADULT INSECT, NATURAL SIZE.

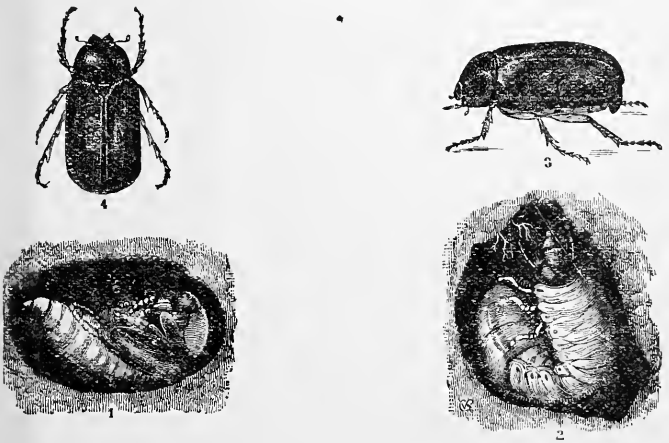


FIG. 6.—MAY BEETLES.
1. Pupa. 2. Larva. 3 and 4. Adults. (*Riley.*)

is to provide for the propagation of its kind; and in providing for posterity the parent insect, guided by an unerring instinct, deposits her eggs just where the offspring is sure to find an abundance of suitable food. A few genera of insects live through the winter in the adult state, but remain during that season in a dormant condition concealed under rubbish or buried within the soil.

Insects which pass through a complete series of changes are said to have *complete metamorphoses*, or *complete transformations*. In these the larva, pupa, and imago bear no resemblance to each other, and the pupæ are unable to move about or to take food.

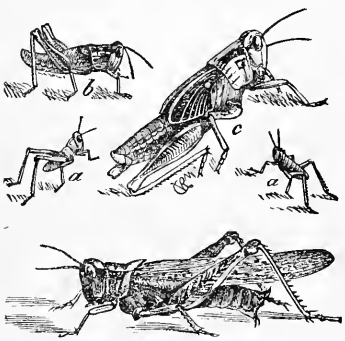


FIG. 7.—ROCKY MOUNTAIN LOCUST. (*Riley.*)

a, *b*. Young nymphs. *c*. Fully developed nymph or pupa. *d*. Adult.

Those insects not distinguished by so complete a series of changes are said to have *incomplete metamorphoses*, or *incomplete transformations*.

In these the immature insect differs less in form and appearance from the adult, gradually increasing in size, and moulting or shedding the skin at times, and when nearly full-grown does not become a quiescent pupa or chrysalis, but simply moults again and continues feeding as before. In the stages corresponding to the larval and pupal periods such insects are known as Nymphs.

As the nymphs approach maturity they differ mainly from perfect insects in being wingless. All true bugs, crickets, and grasshoppers undergo these incomplete changes.

Entomologists divide insects into the following seven orders :—

I. HYMENOPTERA, or membrane-winged insects.
II. COLEOPTERA, or sheath-winged insects.
III. LEPIDOPTERA, or scale-winged insects.
IV. DIPTERA, or two-winged insects.
V. HEMIPTERA, or half-winged insects.
VI. ORTHOPTERA, or straight-winged insects.
VII. NEUROPTERA, or nerve-winged insects.

INSECTS WITH COMPLETE METAMORPHOSES.

1. HYMENOPTERA, OR INSECTS HAVING MEMBRANOUS WINGS.

This order is believed to be the most numerous and includes insects that rank highest in intelligence and in the perfection of physical forms. It includes Bees, Wasps, Ants, Ichneumon-flies, Saw-flies, Gall-flies, and Horn-tails. The order is divided into two sections.

1st. *Stinging Insects*, such as Bees, Wasps, Ants, etc.

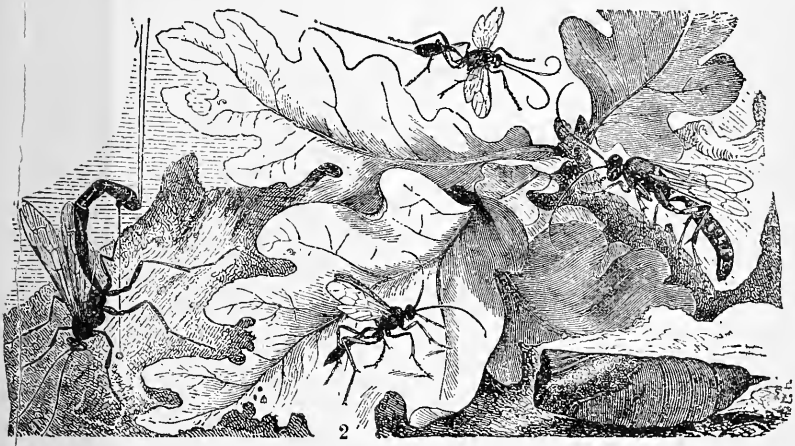


FIG. 8.—PARASITES.

Ichneumon above pupa destroyed by it. Ephialtes in the act of laying eggs upon wood boring larva.

2d. *Piercing Insects*, such as Ichneumon-flies, Gall-flies, Saw-flies, Horn-tails.

This order is distinguished from others by insects having four wings with few veins, and by having both a biting and sucking mouth. Many species of Hymenoptera are beneficial, producing honey and wax, cross-fertilizing our flowering plants, and others destroy vast numbers of injurious insects. Others still are most destructive to orchard and field crops.

FIG. 9.—SAW-FLIES, NATURAL SIZE.

2. COLEOPTERA, OR SHEATH-WINGED INSECTS.

This order is, by some entomologists, believed to out-number all others, more than one hundred thousand beetles being already known. The order is distinguished from others by insects having two pairs of

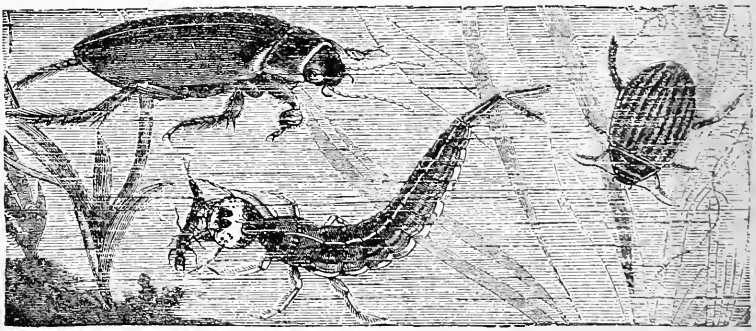


FIG. 10.—CARNIVOROUS WATER-BEETLES.

wings, the upper ones being of a hard, horny texture which form a shield for the protection of the softer wings beneath. The lower wings alone are used in flight. Beetles are masticating insects; they have biting mouth-parts, and undergo complete transformations. They are

divided into True Beetles and Snout-beetles; in the latter the head is prolonged into a beak or snout.

Many beetles do great injury to farm crops; other carnivorous species are decidedly beneficial to man.

The larvæ of beetles are called grubs and borers. Some live in the trunks and limbs of trees, or in the stems of plants, or feed upon foliage, others are aquatic or semi-aquatic in habits, and still others prey upon species injurious to vegetation.

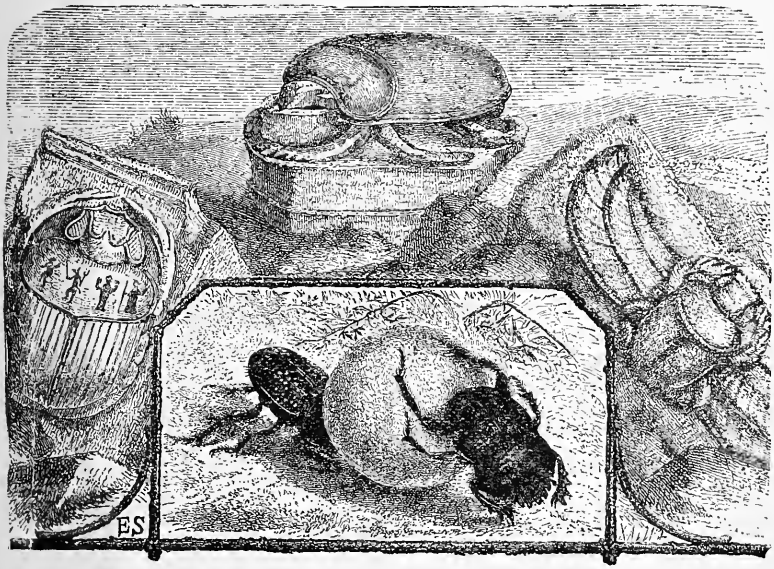


FIG. 11.—TUMBLE-BUG.
Egyptian Sculptures of the Sacred-beetle.

Among true beetles we may mention Ground beetles, Carnivorous Water-beetles, Tiger-beetles, Snapping-beetles (wire-worms), Tumble-bugs, May beetles, Flea-beetles, the Bean and Pea-weevil.

Among destructive leaf-eating beetles are the Colorado Potato-beetle, Cucumber-beetles, several species of Flea-beetles, and the striped Squash-beetle.

Among snout-beetles are the Apple and Plum Curculios, Corn, Granary and Rice Weevils, Bark-beetles, Plum Gouger, Bill-bugs, etc.

FIG. 12.—LADY-BUGS, WITH LARVA AND PUPA. NATURAL SIZE.

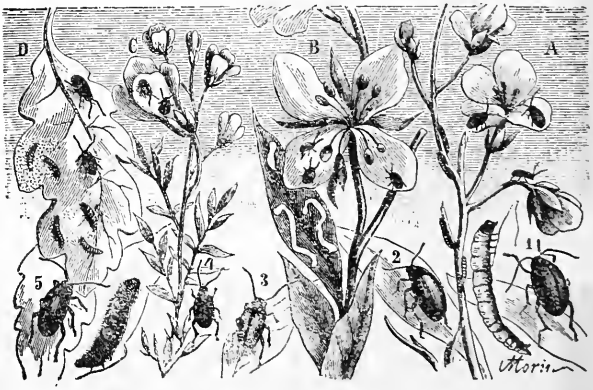


FIG. 13.—DIFFERENT SPECIES OF FLEA-BEETLES WITH THEIR LARVÆ.

3. LEPIDOPTERA, OR SCALE-WINGED INSECTS.

This order is divided into butterflies and moths. The former fly by day, and their feelers or antennæ terminate in a knob. The White

FIG. 14.—GEOMETER, WITH CATERPILLARS AND PUPA.

Cabbage-butterfly, Currant-butterfly, and Parsley Swallow-tail are examples.

The moths have pointed feelers, and in some species branching antennæ. Moths mostly fly at night or by twilight. They are divided into many families such as—Sphinx-moths, Clear-winged moths, Spinners, Cut-worm moths, Span-worms or measuring worms, Snout-moths, Leaf-rollers, Plume-moths, etc.

FIG. 15.—CURRANT-BUTTERFLY. NATURAL SIZE.

FIG. 16.—FRIT-FLY. LARVA, PUPA, AND ADULT. (*Garman.*)

4. DIPTERA, OR TWO-WINGED INSECTS.

This order includes a vast number of species distinguished from all others by having one pair of wings. It includes House-flies, Gad-flies, Bot-flies, Blow-flies, Crane-flies, Fruit-flies, Gnats, Mosquitoes, the Wheat midge, Hessian fly, and many injurious and annoying insects.

In this order belong the fleas, which in their earlier stages possess characteristics of Diptera.

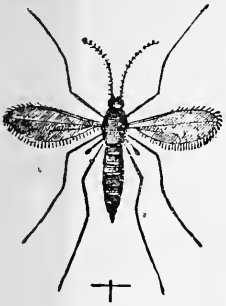
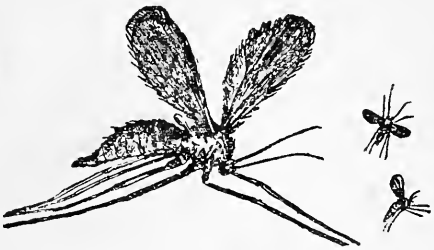


FIG. 17.



HESSIAN FLIES.

FIG. 18.

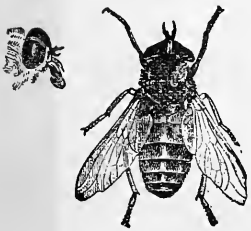


FIG. 19.—GAD-FLY OR HORSE-FLY.

FIG. 20.—THE ADULT OX BOT-FLY. ENLARGED. (*Garman.*)

INSECTS WITH INCOMPLETE METAMORPHOSES.

1. HEMIPTERA, OR HALF-WINGED INSECTS.

It includes, first, the true bugs—a name which should not be applied to the insects of any other order ; second, Harvest-flies, Leaf-hoppers, Plant-lice ; and, third, Lice that are parasitic on mammals.

The first includes many injurious insects, such as the Chinch bug, Squash-bug, Tarnished Plant-bug, Four-lined Leaf-bug. Among the cannibals are the Bed-bug and Soldier-bug, and some species useful to man. Some are amphibious, or aquatic ; among these are the Water-scorpion, the Giant Water-bug or the Electric Light-bug.

The second group includes many families, all of which are plant feeders. Some insects of this group have sound producing organs, dis-

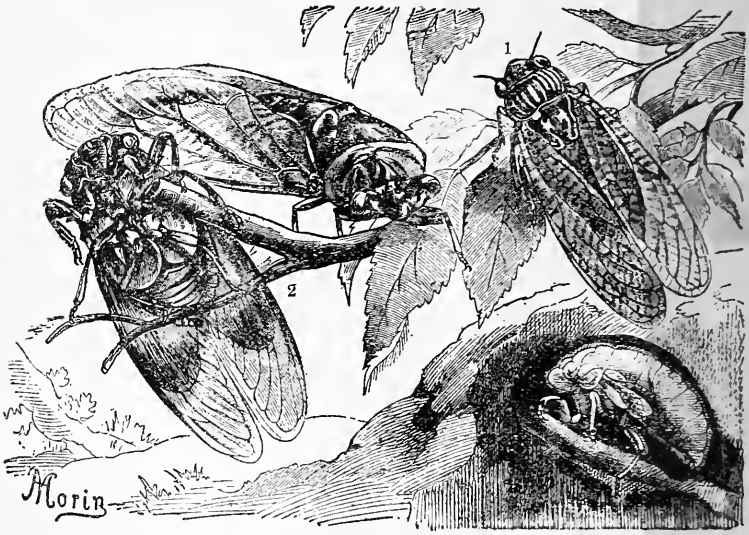


FIG. 21.—HARVEST-FLIES.
1. *Cicada orni*, common in Manna. 2. Singing cicada, with pupa.

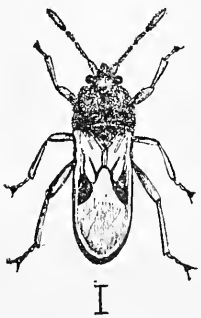


FIG. 22.—CHINCH-BUG.

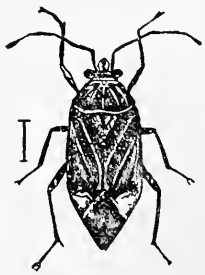


FIG. 23.—TARNISHED PLANT-BUG.

FIG. 24.—SQUASH-BUG.

tinguishing them from most others; among these is the seventeen-year Cicada or Locust.

The Tree-hoppers, as the Buffalo Tree-hopper ; the Leaf-hoppers, as the Grape-vine Leaf-hopper, and the Spital insects are included in this group. Plant-lice and Bark-lice, or scale insects, also belong here. Many of these are both *oviparous* and *viviparous*, that is they reproduce young both by laying eggs and by giving birth to living young. The word oviparous is derived from *ovum*, an egg, and *parere*, to bear

FIG. 25.—THE WINGLESS FORM OF THE GRAIN LOUSE. ENLARGED. (*Garman.*)

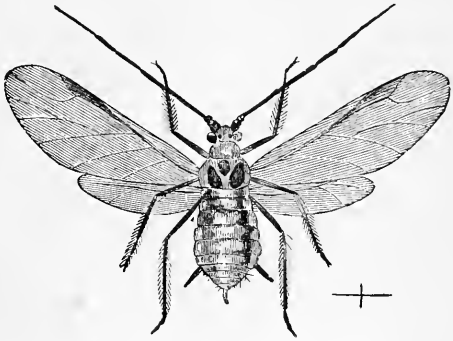


FIG. 26.—THE WINGED FORM OF THE GRAIN LOUSE. ENLARGED. (*Garman.*)

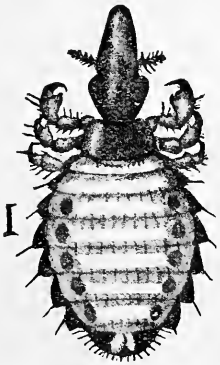


FIG. 27.—SUCKING HORSE LOUSE. (*Osborn.*)

or bring forth, and the term means to bring forth from eggs. Viviparous is from *vivus*, alive, and *parere*, and means to bring forth alive.

The third group comprises lice which are parasitic upon mammals.

The Hemiptera includes many most destructive species and a few that are beneficial.

2. ORTHOPTERA, OR STRAIGHT-WINGED INSECTS.

The families of this order have large heads, strong jaws, straight wings, and long bodies. Crickets, Grasshoppers, Locusts, Katydids,

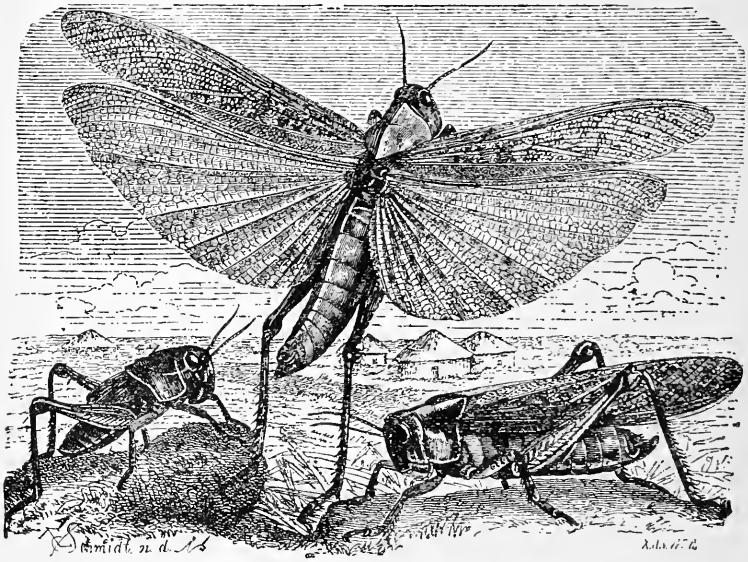


FIG. 28.—MIGRATORY LOCUST DESCRIBED IN THE BIBLE.

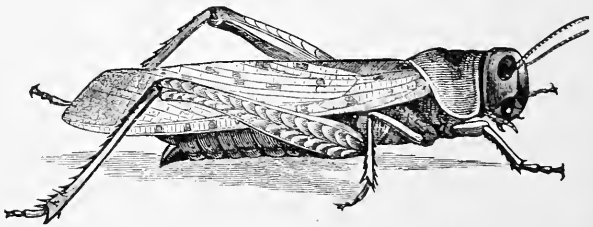


FIG. 29.—BIRD GRASSHOPPER OR AMERICAN LOCUST. (*Riley.*)

Walking-sticks, Cockroaches, etc., belong to this order, which includes some of the most destructive migratory insects known.

INSECTS WITH COMPLETE OR INCOMPLETE METAMORPHOSES.

1. NEUROPTERA, OR NERVE-WINGED INSECTS.

This order is now divided into many smaller ones.

The transformations of the various families are quite different. In some the metamorphosis is complete, while in others it is incomplete. All the insects of this order are distinguished by the fine nerve-like

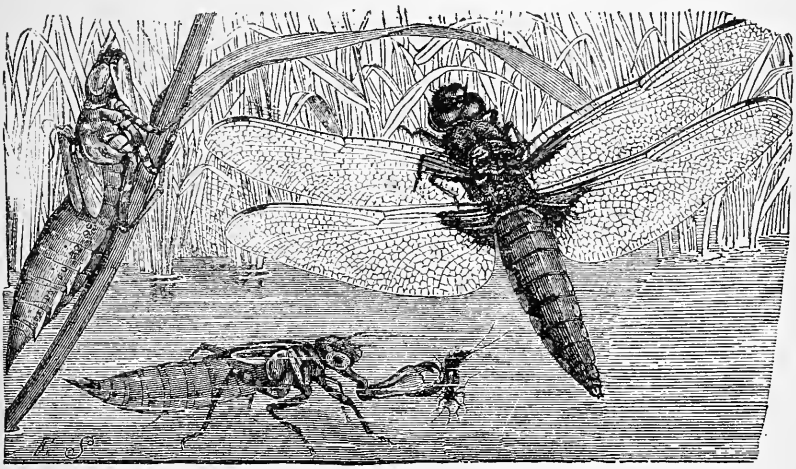


FIG. 30.—DRAGON-FLY, WITH ACTIVE PUPA AND EMPTY PUPAL SKIN.

network of the wings and by biting mouths. Some of those which have complete transformations are Ant-lions, Caddice-flies, and Lace-wings. Those which have incomplete transformations are Dragon-flies, or Mosquito-hawks, May-flies, White-ants. Book-lice also belong to this order. The nerve-winged insects include some species most beneficial, both in the larval and mature states. The larvæ Dragon-flies destroy myriads of larval mosquitoes, and in the adult state are as destructive to winged mosquitoes.

BITING AND SUCKING INSECTS.

In the study of Economic Entomology it is found convenient to classify insects according to the manner in which they take food, since the feeding apparatus or mouth organs furnish an excellent basis for classification. For our purpose it is sufficient to group the different types of feeding organs under two general heads: (1) BITING, and (2) SUCKING mouth parts.

The mouths of biting insects have an upper and lower lip, and two pairs of jaws moving sideways between the lips. Insects having this type of mouth chew up and swallow the plant tissues upon which they feed. These masticating insects possess strong, well-defined, horny jaws, acting horizontally for chewing foliage or fruit, for cutting off the stems of plants, or for boring into the fruits, roots, barks, or trunks of trees and stems of plants. Many gnawing and boring insects belonging to this group may be destroyed by means of poisons applied to the surface of their food plants.

In many other insects the mouth or feeding parts have been so modified, and the departure from the general type seems so great, that we are almost led to the erroneous conviction that a large group of insects have no jaws at all. Among these are the true bugs, the scale insects, the plant lice, and many others. When, however, we examine the mouth parts of the true bugs we find ourselves greatly mistaken in presuming these insects to be wholly without jaws. We discover that they have a long beak-like organ, which when dissected under the microscope is found to contain four minute bristles, which are actually rudimentary jaws; but the action of these modified jaws is very different from that of the jaws of chewing insects. With the bristles the tissues of plants or animals are punctured and the sap or blood, as the case may be, is sucked through the hollow, horny tube into the digestive tract of the insect. Such insects cannot be reached with poisons applied to the surface of plants; the poison will remain harmless on the surface, since in feeding, the insect thrusts its beak into the interior tissues and absorbs the juices of the plant.

The species of this group are known as *Sucking Insects.*

For convenience, we group the masticating insects into *gnawers*, or those which eat the foliage or fruit, or gnaw off the stems of plants; and *borers*, or those which burrow into the roots, stems, wood, etc.

NATURAL AND ARTIFICIAL METHODS OF COMBATING INSECTS.

Economic Entomology brings forward two distinct methods for checking the increase of noxious insects. These are (1) *natural* and (2) *artificial* methods.

The first is based on a knowledge of the habits and life history of insects; the second depends not only on a knowledge of habits and life history, but takes cognizance of the structure of insects, more especially of the mouth parts, whether biting or sucking, and the character of the skin, whether soft and easily affected by irritating chemical substances, or hard and shell-like, and capable of resisting the action of irritants. In the second method experimental science is called to our aid and insecticides become the chief factors in waging warfare on the despoilers of our fields. To fight destructive insects successfully we must know something of their habits, of their transformations in transition from the egg to the adult, and of their bodily structures. This knowledge reveals the weak points in their life histories and points out to us the most vulnerable points of attack.

Some insecticides act both as poisons and as irritants. Some produce suffocation by closing up the breathing spiracles, and others generate gases fatal to animal life.

Both natural and artificial methods should be employed in times of serious danger to crops, but the natural methods are more in harmony with nature and are less liable to kill beneficial insects along with those which are our enemies.

NATURAL METHODS.

In spring many injurious species may be caught in nets before they have become formidable in numbers; others, as, for instance, the Plum Curculio, may be jarred from trees on to sheets spread on the ground beneath, or, as in the case of the Colorado Potato Beetle, may be shaken into pails of water containing a little kerosene oil. Every one destroyed early in the spring, before the eggs have been laid for another generation, is equivalent to many times the number killed later in the season. Bands of folded paper fastened tightly around the trunks of trees will act as barriers to the caterpillars of the Codling Moth, as they try to descend to the earth; and strips of tarred paper or tin tacked around trees, prevent the unwinged females of the Canker-worm Moths from ascending trees to lay their eggs. Under the folds of paper the

insects will congregate, where they are readily found and killed. Many night-flying insects may be attracted by lights or lantern-traps scattered through the fields. The lamps should sit or be hung over a vessel containing water and a little kerosene oil, into which the insects will fall and be killed. The eggs of noxious insects should also be destroyed wherever conspicuous, as is the case with the Tent Caterpillar. The nests may be gathered in winter from infested trees and burned. Dead twigs, leaves, and rubbish of all kinds in orchards or fields, and even stubble and dead grasses, should also be burned. Hogs, if permitted to root in infested soils, will devour vast numbers of subterranean species, and even the much despised crow, though under the ban of universal outlawry, does the farmer a not unfriendly turn in destroying many of the most destructive pests of the farm.

High manuring enables plants to better withstand and to recover from insect injuries. Rapid rotation of crops, diversified farming in infested regions, late or early sowing and plowing, are all, under certain circumstances, effective agencies in killing off or preventing the development of insect pests.

Ditching may often be resorted to to check the marching armies of certain migratory species, and wherever fields can be inundated, harmful insects may be effectually kept under control. Mowing crops early, as, for example, in the case of timothy infested with the Lesser Army Worm, or of various insects attacking red clover, will speedily end the mischief of these so-called worms by starving them to death.

The Monitor moth and insect trap, illustrated in Fig. 31, is the invention of Mr. W. C. Barnard, of Worcester, Mass. These traps are glass jars partially filled with a liquid strongly attractive to many insects. The outside of the jars have flowers painted on them with luminous paint, and the interior arrangement of the trap prevents the escape of insects that enter it.

Professor Fernald has suggested that these traps be set at night only and be kept closed during the day, since most of the injurious insects trapped fly at night, while many beneficial ones are destroyed if the trap remains open during daytime.

To our friends of the South we suggest this trap as a means of destroying the night-flying moths of the Cotton Caterpillar (*Aletia xylina*).

In the spring of 1893 Professor Shaler recommended that the Monitor trap be tried for trapping the male Gypsy Moths by exposing the females.

"This was done," says Professor Fernald, "by enclosing the females

in boxes covered on two sides by fine wire netting, and attaching to such boxes two sheets of paper covered with a resinous coating, to which the male moths adhered. Fifteen traps were exposed in Malden, and 1771 male moths were caught. The fact that so many moths were destroyed at a small expense seems proof that trapping will prove an effectual and inexpensive method of preventing the increase in the numbers of the moth, especially as the males now seem to be comparatively scarce."

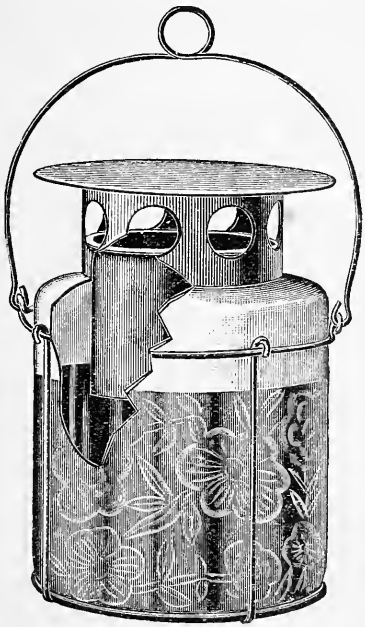


FIG. 31.—BARNARD'S MOTH TRAP.

Perhaps our most important natural aids are the least regarded by farmers. We refer to beneficial wild animals—mammals, birds, reptiles, and fishes. Not only do insects have many natural enemies among predaceous and parasitic related species, but the higher animals —birds, skunks, moles, snakes, toads, lizards, frogs, and fishes—are some of the most persistent and energetic foes of noxious insects. Many wild animals hunted down and almost exterminated are our benefactors, and by destroying the enemies of our crops do a hundred

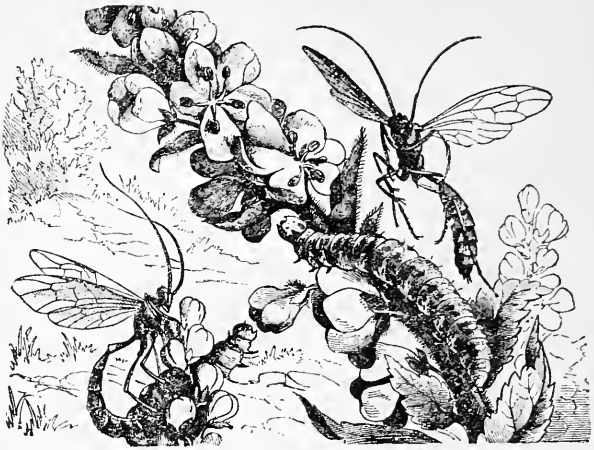


FIG. 32.—PARASITE (*Ophion*) INSERTING EGG IN CATERPILLAR.

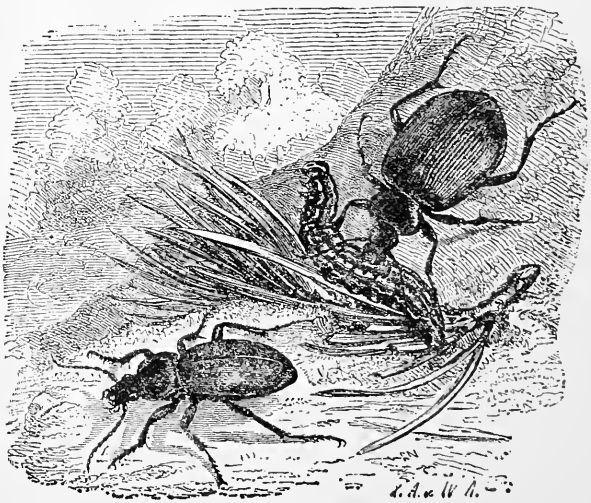


FIG. 33.—GROUND-BEETLES.

fold more good than the seemingly little harm which these animals do in levying a trifling tribute from our fields.

Insects are also subject to bacterial diseases, which carry them off in inconceivably large numbers. The introduction of contagious diseases of parasitic and cannibal insects is now receiving the attention of economic entomologists and gives promise of much future good. Among cannibal insects that help to hold the injurious species in check we may mention the Four-winged Dragon-flies, Two-winged

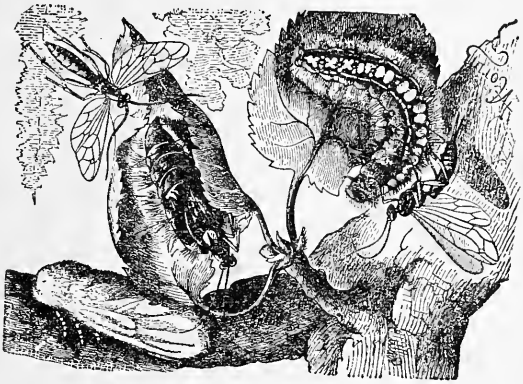


FIG. 34.—PARASITES.

Pimpla female laying egg in caterpillar; another issuing from pupa of moth; below it a male, natural size.

Robber-flies, Lady-beetles, and Black Ground-beetles, found everywhere under rubbish and stones. Many parasitic species also burrow into the bodies of injurious insects and develop at their expense.

ARTIFICIAL METHODS.

The phenomenal growth of agriculture in the United States during the present century has been most favorable to the more than normal development of insect life; especially favorable have been the conditions for the increase of insects injurious to farming and fruit growing. The finely balanced relations between the animal and vegetable kingdoms have been disturbed, and the conditions existing so long as the great interior continent was covered with virginal vegetation have been abruptly terminated. Such a derangement is always to be expected in the agricultural development of a new country. The

opening of vast areas to cultivation and the growth of crops upon a scale of extraordinary magnitude is most favorable to the life conditions of certain injurious species. They will necessarily come first and multiply enormously, for at first there are none of the natural checks on increase which prevail in an undisturbed state of nature. With the coming of the noxious species will also appear a few of their natural foes. Conditions favorable to the increase of the former also favor the multiplication of the latter, and with time and more diversified farming the disturbed relations between plants and animals will be restored. The old enemies of destructive insects will multiply, parasitic species that prey upon our foes will vastly increase in numbers, and bacterial forms of disease, to which insect life is so susceptible, will contribute to the re-establishment of a natural state of things.

But even in old countries the nicely balanced relations between plants and animals are occasionally thrown out of equilibrium. Conditions may favor the development of certain noxious species, and for a time the normal relations are disturbed. But in old countries these disturbing influences are less violent and rarely cause the widespread distress which has at times desolated newly settled communities.

Nowhere in the economy of living nature have we more clearly exemplified the reciprocal influences of life upon life, or the dominancy of external circumstances in modifying the struggle for existence, than is presented in the study of insect life in our own country to-day.

From what has been said of the structure of the mouth parts of insects and of their habits in feeding, it is quite plain that masticating species only can be destroyed by the use of poisons which enter the alimentary canal along with the natural food. For sucking insects we must resort to some other means. In dealing with noxious insects two classes of insecticides are now in very general use. *First*, those which adhere to the foliage, bark, etc., of plants and are eaten by masticating insects along with their food ; and, *second*, insecticides which kill by contact. The last are either irritants which produce death by coming in bodily contact with the pest, causing irritation, or substances that close up the breathing pores or spiracles and produce death by suffocation. The breathing organs of insects are not like those of the higher animals. If we look at the body of a locust under a magnifying-glass we find in the segments of the body minute breathing holes or spiracles. An examination reveals a system of air tubes extending to all parts of the body. These are the breathing organs of the insect. The efficiency of many of our insecticides is due to the fact that they form a delicate film over the body, closing up the breathing spiracles and

causing suffocation. In addition to these deadly substances resort is sometimes made to others of offensive odor, or that evolve deadly gases or fumes, or that act as barriers to some insects which occasionally migrate in vast armies from place to place.

INSECTICIDES.

The principal insecticides, or insect destroyers, are: Paris Green, London Purple, White Arsenic, White Hellebore, Pyrethrum, Tobacco, Kerosene Emulsion, Coal Tar, Benzine, Turpentine, Carbolic Acid, Bisulphide of Carbon, and the Resin washes hereafter described. The fungicide, *Bordeaux Mixture*, is also beginning to be used to some extent in connection with Paris green for destroying masticating insects. When thus used the mixture serves the double purpose of killing insects and protecting plants from certain cryptogamic diseases. These diseases or fungi, mildews and blights, as they are more commonly called, are minute parasitic plants of low organization which develop from spores somewhat analogous in function to the seeds of higher plants.

Paris Green.—For general use this is probably the best and safest of the arsenical compounds.

It is composed of arsenious acid and copper, and contains, when pure, from 56 to 58 per cent. of arsenious acid. Paris green is very slightly soluble in water, but by the use of a little lime water it is rendered practically insoluble; even when used without lime water it is less liable to injure tender foliage than London purple or white arsenic. It is desirable that a compound of arsenic for use as an insecticide should be insoluble in cold water, for soluble arsenical preparations are destructive to foliage. The arsenical compounds are most effectually and cheaply used in suspension with water. Such mixtures are more readily made and answer every purpose for which dry mixtures are used.

In dry mixtures Paris green may be used with such diluents as flour, land plaster, sifted coal ashes, or fine, dry road dust. Coal ashes are preferable to wood ashes, as the potash of the latter renders some of the arsenic soluble, which is then liable to burn the foliage. The writer uses a dry mixture made thus:—

Paris green, ...	1 pound.
Flour, ...	5 pounds.
Land plaster, ...	100 "

When damaged flour or the refuse of flour mills is used the proportion should be from 50 to 75 pounds of diluent to one pound of Paris green. The following formula is given in Bulletin No. 92 of the North Carolina Experiment Station :—

Paris green or London purple, ...	1 pound.
Wheat flour, ...	3 pounds.
Dry road dust or sifted ashes, ...	50 "

Water mixtures are not only usually cheaper and more easily made and managed, but can be used at all times regardless of winds and the dry or wet condition of foliage. Paris green is over three times as heavy as water, and, consequently, unless kept constantly agitated, settles rapidly to the bottom of the vessel. The addition of a small quantity of wheat, rye, or rice flour not only helps to hold the heavy poison in suspension, but forms on the sprayed foliage a thin film of glaze not readily washed off by summer showers.

The writer prefers a liquid mixture of Paris green and water to which one quart of glucose or molasses is added for each fifty gallons of water. A paste made of wheat, rye, or rice flour may be used instead of glucose or molasses to render the insecticide more adhesive. If paste is used it should be made thin, stirred into the water, to which the poison is to be added, and the water allowed to stand for thirty minutes or more. Mix up the Paris green with a little water, and beat it into a fine, thin batter, free from lumps, before stirring into the water. Mix thoroughly before use.

When thus made the heavy poison is more readily retained in suspension, and a fine coating of glaze adheres to the plants. For each 100 gallons of mixture eight ounces of fresh caustic lime, slacked in about two gallons of water, should be added.

The writer has experimented the past season with powdered soapstone or steatite as a possible valuable addition to insecticides and fungicides. Used in spraying in connection with Paris green, steatite undoubtedly helps to hold the poison in suspension, and the insecticide adheres with great tenacity and for a longer time to the foliage, nor is it so readily washed off by showers.

The following is the formula used by the writer :—

Paris green, ...	4 ounces.
Steatite in powder, ...	8 "
Caustic lime, ...	4 "
Water, ...	50 gallons.

Mix the Paris green and steatite, and beat into a fine batter before adding to the water. Churn the materials together and apply with a spraying machine in the usual manner.

London Purple is chiefly arsenite of calcium, a residue obtained in the manufacture of aniline dyes. It does not contain quite so much arsenic as Paris green, but is cheaper, and being also much lighter will remain in suspension for some hours with but little precipitation. It is more soluble in water than Paris green and must be used cautiously at first, being very liable to injure foliage. The retail price is usually near one-half the price of Paris green.

Owing to the variable composition of London purple it is less reliable than Paris green, but the low price, lightness, and distinct color make the former poison a desirable insecticide when of known composition and when used with caution.

In liquid preparations use in the same proportion as Paris green, but add no paste to the water, as this poison, unlike Paris green, is quickly precipitated by the addition of paste. Lime water at the rate of four gallons to each one hundred gallons of water should be added to prevent the caustic action of the poison on the foliage.

For potatoes the liquid preparations of Paris green or London purple seem most effective when used at the rate of from 75 to 100 gallons of water to each pound of poison.

White Arsenic (arsenic trioxide) is rarely used. It has no advantages over Paris green or London purple and is objectionable because of its solubility and the want of some bright color to distinguish it from other white powders. It should be avoided and discountenanced by farmers as a dangerous poison to have about the farm.

White Hellebore.—The powdered root of *Veratrum album*, an acrid and poisonous drug used in medicine. Hellebore may be used as a powder or in the form of decoction. When used dry the pure powder should be diluted with three or four parts of flour and be blown on infested plants from a powder bellows. As a decoction use one heaping tablespoonful of the drug to about two gallons of water. White hellebore is used generally for destroying insects that infest the gooseberry and currant and also for killing rose slugs. This insecticide kills both by contact and by being eaten.

Decoction of White Hellebore.—Take of

White hellebore, ...	1 ounce
Common glue, ...	1 "
Water, ...	3 gallons.

The foregoing formula is given by Professor Beckwith in Bulletin 18 of the Delaware Experiment Station.

The writer makes two decoctions of hellebore thus :—

1. Over one ounce of the drug in powder pour from one to two gallons of boiling water, stir, and cover the vessel with a board and allow the contents to cool. Add the glue, which has been previously dissolved, or instead of glue use a half pint of thin paste made with a little flour, and add sufficient water to make three gallons.

2. Over one ounce of white hellebore in powder pour two gallons of boiling water and allow the decoction to cool, as in No. 1. Take one ounce of powdered soapstone or steatite, mix with a little water, and add to the decoction, to which enough water should be added to make three gallons.

Pyrethrum.—The powdered blossoms of several species of pyrethrum are known in the market as Persian insect powder, Dalmatian insect powder, and Buhach, the latter being grown in California.

This powder is sold under many trade names, and as found in the markets is often so adulterated as to be worthless, or nearly so. The imported powder of good quality may be had from reliable dealers in our large cities, and should be always purchased in preference to the cheaper articles offered by irresponsible parties. Pyrethrum is non-poisonous except to insect life. For many insects, the fresh, imported powder can be diluted with several times its bulk of flour. The mixture should be allowed to stand for several hours before use. Buhach, the California product, when pure is very effective. A decoction of pyrethrum similar to that made of hellebore may also be used.

Tobacco is especially useful for destroying insects that infest domestic animals and greenhouse plants. The stems and dust are used in decoction or as a fine powder, and act both as an insecticide and as a fertilizer.

Tobacco Decoction.—

Tobacco stems, leaves, or dust, ...	1 pound.
Water, ...	2 to 3 gallons.

Boil the tobacco for twenty minutes, and keep covered until cool ; use undiluted, with a syringe or spray.

This decoction is an excellent fertilizer, and is especially effective as an insecticide for plant-lice, soft caterpillars and insects that infest indoor plants.

Kerosene Emulsion.—This insecticide acts as an external irritant, that is, it kills by contact. It ranks first in importance as a

remedy for non-masticating or sucking insects. It is also very useful for applying about the roots of plants to destroy root-infesting lice and larvæ in the soil. Aside from this wide field of usefulness for destroying plant-lice and scale insects, kerosene emulsion is effective against many masticating insects. Many modifications of the formula for the emulsion as first published by Dr. Riley have been extolled, but we know of none so easy to prepare, or that gives so good an emulsion, as the one recommended by the Division of Entomology of the United States Department of Agriculture.

Riley-Hubbard Formula—

		Per cent.
Kerosene oil,	2 gallons.	67
Common soap or whale oil soap,	½ pound.	33
Water,	1 gallon.	

Dissolve the soap over a brisk fire in boiling water, and when in solution remove from the fire and add the oil. Churn the mixture for a few minutes by means of a force-pump and spray nozzle, or if these are not at hand, beat with a paddle until a cream-like emulsion is obtained. Care must be taken that the oil is thoroughly emulsified. If free oil is present it will rise to the top of the liquid after dilution, and injure the foliage. If well made, the emulsion thickens on cooling into a jelly-like mass which adheres, without oiliness, to the surface of glass. In making kerosene emulsion use rain water if possible, or, if the well-water is hard, add an ounce of lye or a little baking (bicarbonate of) soda to the water. For scale insects dilute one part of the emulsion with nine parts of cold water ; for many other insects, one part of emulsion to fifteen parts of water, and for soft insects, like plant-lice, from twenty to twenty-five parts of water may be used to one of the emulsion.

Professor Cook's Formula for Kerosene Emulsion :—

Soft soap,	1 quart.
Water,	2 quarts.
Kerosene oil,	1 pint.

Dissolve the soft soap as in the Riley-Hubbard formula, remove from fire and add the oil. Churn until completely emulsified. One-fourth pound of hard soap may be used instead of the soft soap.

Dilute the emulsion with an equal bulk of water before using.

Milk-Kerosene Emulsion :—

Kerosene,	2 gallons.
Milk (sour),	1 gallon.

Made in the same manner as the former except that no heat is necessary. To sweet milk add a little vinegar or acid. With sweet milk difficulty will be experienced in producing an emulsion. The degree of sourness, however, seems to exert little effect; the milk may be slightly turned or in the form of clabber. Use the same as the soap emulsion. This is the best emulsion for use in hard water regions.

In limestone regions where the water is strongly impregnated with lime or magnesia there is some separation of free oil on dilution. The quantity will be variable, depending upon the percentage of lime or magnesia in solution in the water.

The separation of oil when hard water is used, is induced by the chemical action of the lime and magnesia salts on the soap, resulting in the formation of insoluble oleate, palmitate or stearate of lime and magnesia, or of all these compounds, and the consequent freeing of the oil which was held in the form of emulsion. In hard water regions the milk-kerosene emulsion is to be preferred since there is no soap present, and consequently these chemical reactions do not take place.

Pyrethro-kerosene Emulsion.—This insecticide is made by percolating kerosene oil through pyrethrum powder and using the yellow, oily percolate instead of kerosene alone, as in the Riley-Hubbard formula.

The formula as published in Bulletin No. 15, Arkansas Exp. Sta., Dec., 1890, is as follows:—

Hard soap, ...	1 pound.
Kerosene extract of pyrethrum, ...	1 gallon.
Water, ...	1 "

Emulsify as in the Riley-Hubbard formula.

Experiments were conducted at the Arkansas Experiment Station to learn the least amount of this emulsion that would be effective in destroying the cotton worm.

From these experiments it appears that one part of the emulsion to 450 or 500 parts of water is sufficient. When diluted with more than 900 parts of water, the young worms were not killed. When treated with from 500 to 900 parts of water to one of emulsion the young and half-grown worms seldom survived treatment; and when the solution was reduced much below one part to 450, death came within a few minutes. The application of one part of emulsion to 500 parts of water caused the worms to die in from 12 hours to two days, according to size. Tried on the pupæ, all those that were exposed by

an opening in the web or leaf sufficient to be touched by the solution were quickly killed, otherwise they were not injured. (See Bulletin No. 15, Arkansas Exp. Sta., Dec., 1890.)

To obtain one gallon of the pyrethrum-kerosene extract as required in this formula, about one and a half gallons of kerosene oil must be used. Fully one-third of the menstruum remains in the pyrethrum to be thrown away after the operation is performed. The writer has made and used a pyrethro-kerosene emulsion which combines all the advantages of the above formula, and that is much more easily made. It is thus: Take of

Kerosene oil, ...	1 gallon.
Hard soap, ...	1 pound.
Pyrethrum powder, ...	1 pound.
Water, ...	1 gallon.

Dissolve the soap as in the Riley-Hubbard process and replace the water lost by evaporation.

When the soap is all dissolved, add the pyrethrum to the boiling solution, stir thoroughly for one or two minutes, and allow the materials to boil for about three minutes. Remove from the fire, add the kerosene and churn until a thick emulsion is obtained. By this method a very firm pyrethro-kerosene emulsion is obtained, which, in dilution, works admirably with a force-pump and nozzle; the process of filtration, which is not likely to be well performed by the farmer, is thus avoided, and a cheap and very effective emulsion obtained.

Coal Tar.—Used to some extent in the West to protect crops from migrating insects. The field to be protected is surrounded by tar placed in a V-shaped excavation, which is most readily made with the corner of a hoe or the point of a plow.

Carbolic Acid.—Crude carbolic acid with soft or hard soap forms an excellent wash for destroying bark-lice, and is also effective against several borers.

Carbolic Acid Wash—

Hard soap, ...	1 pound.
Water, ...	2 gallons.
Crude carbolic acid, ...	1 pint.

Heat to boiling, and when the soap is dissolved, add the carbolic acid. Dilute with one-half its bulk of water, and use with a stiff brush for cleaning the bark of apple and other fruit trees infested with scale or bark lice. May also be used as a protection against borers by smearing the wash about the base of tree trunks. Do not use on the foliage.

Carbon Bisulphide is a very volatile and highly inflammable, colorless liquid, which as found in trade has a most disagreeable odor, due to the presence of sulphuretted hydrogen. Bisulphide of carbon is used for destroying Grape Phylloxera and insects infesting stored grain. It can be used with perfect safety, provided no lights or fire are brought about when being used. Bisulphide of carbon rapidly volatilizes when exposed to the air, giving off heavy poisonous fumes, which sink through the entire mass of grain, suffocating whatever pest may be present. Since the fumes are poisonous to animal life, care should be taken to remove farm animals from buildings while using this substance, and, also, not to inhale the fumes.

Resin Washes.—The formulas and directions for making the following resin washes are given in full, as published by the Division of Entomology, United States Department of Agriculture, in Farmers, Bulletin, No. 7, pages 6 and 7.

"These insecticides act by contact, and also, in the case of scale insects by forming an impervious coating which effectually smothers the insect treated. These resin washes vary in efficiency according to the insect treated. Experience has shown that the best formula for the red scale (*Aspidiotus aurantii* Maskell) and its yellow variety (*A. citrinus* Coquillett) is as follows:—

Resin, ...	18 pounds.
Caustic soda (70 per cent. strength), . .	5 "
Fish oil, ...	2½ pints.
Water to make, ...	100 gallons.

"The necessary ingredients are placed in a kettle and a sufficient quantity of cold water added to cover them. They are then boiled until dissolved, being occasionally stirred in the meantime, and after the materials are dissolved, the boiling should be continued for about an hour, and a considerable degree of heat should be employed so as to keep the preparation in a brisk state of ebullition, cold water being added in small quantities whenever there are indications of the preparation boiling over. Too much cold water, however, should not be added at one time, or the boiling process will be arrested and thereby delayed, but by a little practice the operator will learn how much water to add so as to keep the preparation boiling actively. Stirring the preparation is quite unnecessary during this stage of the work. When boiled sufficiently it will assimilate perfectly with water, and should then be diluted with the proper quantity of cold water, adding it slowly at first and stirring occasionally during the process. The un-

diluted preparation is pale yellowish in color, but by the addition of water it becomes a very dark brown. Before being sprayed on the trees it should be strained through a fine wire sieve, or through a piece of Swiss muslin, and this is usually accomplished when pouring the liquid into the spraying tank, by means of a strainer placed over the opening through which the preparation is introduced into the tank.

The preparing of this compound will be greatly accelerated, if the resin and caustic soda are first pulverized before being placed in the boiler, but this is quite a difficult task to perform. Both of these substances are put up in large cakes for the wholesale trade, the resin being in wooden barrels, each barrel containing a single cake, weighing about 375 pounds, while the caustic soda is put up in iron drums containing a single cake each, weighing about 800 pounds.

The soda is the most difficult to dissolve, but this could doubtless be obviated by first dissolving it in cold water and then using the solution as required. This insecticide may be applied at any time during the growing season.

A stronger wash is required for the San José scale (*Aspidiotus perniciosus* Comstock), and the following formula gives the best results :—

Resin, ...	30 pounds.
Caustic soda (70 per cent.)	9 "
Fish oil, ...	4½ pints.
Water enough to make	100 gallons.

Place all the ingredients in a kettle and cover with water to a depth of 4 or 5 inches ; boil briskly for about two hours, or until the compound can be perfectly dissolved with water. When this stage is reached the kettle should be filled up with water, care being taken not to chill the wash by adding large quantities of cold water at once. It may be thus diluted to about 40 gallons, the additional water being added from time to time, as it is used.

This preparation should only be applied during winter or during the dormant period ; applied in the growing season it will cause the loss of foliage and fruit.

In the application of both these washes a very fine spray is not essential, as the object is not simply to wet the tree, but to thoroughly coat it over with the compound, and this can be best accomplished by the use of a rather coarse spray, which can be thrown upon the tree with considerable force.

Kerosene Ointment. (Bul. 78, North Carolina Exp. Sta.) :—

Lard,	1 pound.
Powdered sulphur,	2 ounces.
Kerosene oil,	¼ pint.

Mix the lard and sulphur, and then add the oil. For use on poultry. Apply by rubbing.

1. Corrosive Sublimate Wash. (Bul. 92, North Carolina Exp. Sta.)—

Corrosive sublimate,	1 ounce.
Soft soap,	10 gallons.
Alcohol or wood spirit,	1 pint.
Water,	sufficient.

Directions.—Dissolve the corrosive sublimate in the alcohol or spirit, and stir it into the soft soap, add water enough to make a stiff paint, and apply to base of trees with a brush. This is said to be a reliable remedy against the borers of the apple, and also good for the woolly louse.

2. Cement Wash. (Bul. 92, North Carolina Exp. Sta.)—

Hydraulic cement,	5 tablespoonfuls.
Sour- or butter-milk,	1 gallon.

Directions.—Mix, and use at once. Apply to base of tree with a stiff brush. An effective remedy for the peach tree borer.

Bordeaux Mixture.—The following is the official formula for Bordeaux Mixture, published in Farmers' Bulletin, No. 7, U. S. Department of Agriculture :—

"In a barrel that will hold 45 gallons, dissolve 6 pounds of copper sulphate, using 8 or 10 gallons of water, or as much as may be necessary for the purpose. In a tub or half barrel slake 4 pounds of *fresh* lime. When completely slaked, add enough water to make a creamy whitewash. Pour this slowly into the barrel containing the copper sulphate solution, using a coarse gunny sack stretched over the head of the barrel for a strainer. Finally fill the barrel with water, stir thoroughly, and the mixture is ready for use. Prepared in this way the cost of 1 gallon of the mixture will not exceed 1 cent, the price of copper sulphate being 7 cents per pound and lime 30 cents per bushel. In all cases it is desirable to use powdered copper sulphate, as it costs but little more and dissolves much more readily. It is highly important also that fresh lime be used."

By the addition of Paris green or London purple to Bordeaux mixture, we have a most excellent insecticide and fungicide combined.

For peaches, plums, and other stone fruits, 2 ounces of Paris green to 45 gallons of the mixture may generally be used without injury to the foliage. For other fruits use 4 ounces of Paris green or London purple to the same quantity of mixture.

SPRAYING APPARATUS.

Spraying machines of excellent workmanship are now so abundant and so generally advertised in the agricultural papers, that it is not within our province to discuss them here. In the catalogues of manu-

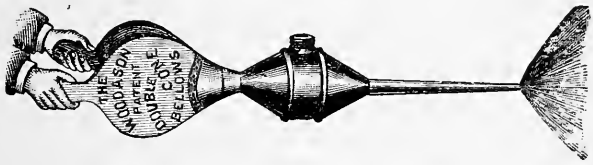


FIG. 35.—WOODASON DOUBLE CONE BELLOWS.

facturers of these implements, our readers will find fully described a varied assortment of bucket, knapsack, barrel, and horse-power sprayers. We wish here merely to give a word of caution to those who have had no experience in the use of spraying machines. A cheap, poorly made implement is dear at any price or at no price at all, for it is liable to get out of order just at a time when a day's delay may mean the loss of a crop. The so-called cheap machines mostly have iron cylinders

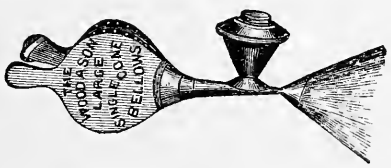


FIG. 36.—WOODASON SINGLE CONE BELLOWS.

and leather valves, which are soon rendered useless by the action of corrosive substances used in spraying. We recommend our readers to buy only machines having all brass cylinders, and all the working parts which are exposed to the action of spraying materials should be of brass or brass-lined. Ball valves should not be of rubber, for they are very soon destroyed by kerosene emulsion. It is also important to have a good nozzle—one that throws a fine mist-like spray. The Vermorell

and Climax or Nixon nozzles are the most reliable known to us. The Knapsack sprayer, designed to be carried on the back by the operator, is most useful for garden work, and for dwarf trees and small vineyards.

For general orchard work we recommend a barrel sprayer mounted on wheels and operated by hand-power.

The horse-power sprayers are mounted tanks worked by horse-power and are designed for the use of large orchardists.

FIG. 37.—WOODASON LIQUID SPRAYING BELLOWS.

Figs. 35, 36, 37, show the powder and liquid spraying bellows invented and manufactured by Thomas Woodason, of Philadelphia. These implements are most useful for indoor and garden work, and are regarded as the best made in this country.

Spraying apparatus of all kinds should be strong, light, and durable, and be capable of supplying from 40 to 60 pounds pressure on the discharge pipe. The pumps should be powerful and the handle long, for spraying by hand power is hard work, and with the handle long a greater power is obtained.

THE USE OF INSECTICIDES FROM THE HYGIENIC STANDPOINT.

At this late day it would seem almost useless to bring forward evidence to disprove the fears of a few ignorant alarmists whose voices are occasionally heard exaggerating the dangers to life and health from the use of insecticides and fungicides. The fact is, there are no hygienic objections to the employment of these preparations, provided ordinary common sense is exercised in their use. The compounds of arsenic are the only insecticides used in spraying at all dangerous, and the dangers from these have been very greatly exaggerated by those not conversant with the facts. We quote the following from *Farmers' Bulletin*, No. 7, United States Department of Agriculture, to show how utterly baseless and misleading such fears are :—

"Paris green and London purple have for many years been extensively used in this country as insecticides, and a case of fatal poisoning from their use as such has never been substantiated.

"The only danger lies in having the poisons about a farm or planta-

tion in bulk. In the early days of the use of Paris green against the Colorado Potato Beetle, a great deal of opposition was developed on account of the supposed danger, and only recently the sale of American apples in England has received a set-back owing to the supposed danger of arsenic poisoning from their consumption. The question as to whether arsenic may be absorbed by the growing plant in any degree was long ago settled in the negative by the best chemists in the country. Dr. William M'Murtrie, formerly chemist of this Depart ment, in 1878, showed that even where Paris green was applied to the soil in such quantities as to cause the wilting and death of the plants, the most rigorous chemical analysis could detect no arsenic in the composition of the plants themselves." * * * * *

"It would seem at first glance, that the use of an arsenical poison upon a plant like cabbage would be very unsafe to recommend, yet Paris green and London purple are used upon this crop to kill the several species of leaf-eating worms which are so destructive to it, and an absolute absence of all danger, where the application has been properly made, has been recently shown by Professor Gillette of the Agricultural Experiment Station of Colorado, by the following *reductio ad absurdum*: 'Where the green is dusted from a bag in the proportion of one ounce of the poison to 100 ounces of flour and just enough applied to each head to make a slight show of dust on the leaves, say, for twenty-eight heads of cabbage, one ounce of mixture, the worms will all be killed in the course of two or three days, while the average amount of poison in each head will be about one-seventh of a grain. Fully one-half of the powder will fall on the outside leaves and on the ground, and thus an individual will have to eat about 28 heads of cabbage in order to consume a poisonous dose of arsenic, even if the balance of the poison remained after cooking.'

"In case of spraying apple orchards for the codling-moth, there is scarcely a possibility of injury to the consumer of the fruit. A mathematical computation will quickly show that where the poison is used in the proportion of 1 pound to 200 gallons of water (the customary proportion) the arsenic will be so distributed through the water that it will be impossible for a sufficient quantity to collect upon any given apple to have the slightest injurious effect upon the consumer. In fact, such a computation will indicate beyond all peradventure that it will be necessary for an individual to consume several barrels of apples at a single meal in order to absorb a fatal dose, even should this enormous meal be eaten soon after the spraying, and should the consumer eat the entire fruit.

"As a matter of fact, careful microscopic examinations have been made of the fruit and foliage of sprayed trees at various intervals after spraying, which indicate that after the water has evaporated the poison soon entirely disappears, either through being blown off by the wind or washed off by rains, so that after fifteen days hardly the minutest trace can be discovered.

"In the line of actual experiment, as indicating the very finely divided state of the poison and the extremely small quantity which is used to each tree, Prof. A. J. Cook, of the Michigan Agricultural College, has conducted some striking experiments. A thick paper was placed under an apple tree which was thoroughly sprayed on a windy day so that the dripping was rather excessive. After the dripping had ceased, the paper (covering a space of 72 square feet) was analyzed and four-tenths of a grain of arsenic was found. Another tree was thoroughly sprayed and subsequently the grass and clover beneath it was carefully cut and fed to a horse without the slightest sign of injury.

"The whole matter was well summed up by Professor Riley in a recent lecture before the Lowell Institute, in Boston, in the following words:

"'The latest sensational report of this kind was the rumor, emanating from London within the last week, that American apples were being rejected for fear that their use was unsafe. If we consider for a moment how minute is the quantity of arsenic that can, under the most favorable circumstances, remain in the calyx of an apple, we shall see at once how absurd this fear is; for, even if the poison that originally killed the worm remained intact, one would have to eat many barrels of apples at a meal to get a sufficient quantity to poison a human being. Moreover, much of the poison is washed off by rain, and some of it is thrown off by the natural growth of the apple, so that there is, as a rule, nothing left of the poison in the garnered fruit. Add to this the further fact that few people eat apples raw without casting away the calyx and stem ends, the only parts where any poison could, under the most favorable circumstances, remain, and that these parts are always cut away in cooking, and we see how utterly groundless are any fears of injury, and how useless any prohibitive measures against American apples on this score.'"

In September, 1891, the New York City Board of Health seized and destroyed large quantities of grapes, on the ground that they had been sprayed with copper compounds and were consequently poisonous. This wholly unjustifiable action, which was not even based upon a reasonable presumption, caused serious loss to many grape growers.

Mr. D. G. Fairchild, representing the United States Department of Agriculture, visited the Hudson River regions, where the grapes were grown which had been seized. He took pains to secure the worst sprayed bunches of grapes obtainable from vineyards from which the condemned grapes came. The grapes were given to the chemist of the New York Agricultural Experiment Station at Geneva for analysis. In Bulletin No. 41, New York Agr. Exp. Sta., April, 1892, the results of analyses are thus summarized :

"1. The amount of copper estimated as metallic copper found on the *berries*, was very constant in the different samples, averaging 1-120th of a grain for each pound of fruit (berries and stems).

"2. The amount of copper, estimated as metallic copper, found on the stems, varied from 1-90th to 1-14th of a grain for each pound of fruit, berries and stems, and averaged 1-30th of a grain.

"3. If the copper were on the berries in the form of sulphate of copper, each pound of berries would contain 1-30th of a grain of copper sulphate. When copper sulphate is prescribed by physicians as a tonic or astringent, the dose is from one-fourth to two grains. Hence, if a person were to eat and swallow the grape skins as well as the pulp of the berry, it would be necessary to eat from $7\frac{1}{2}$ to 60 pounds of grapes in order to get a toxic dose of copper sulphate.

"To get an amount of copper that would be regarded as serious if taken at one dose, one would need to eat not less than 3000 pounds of grapes, skins included, or not less than 500 pounds, including berries and stems ; and it is safe to say that if any attempt were made to get a dangerous dose of copper into the body in this way in a short time, a person would be in a dangerous condition many times from the grapes alone, before running any risk from the copper.

"To state the matter in another way, if one were to eat each day one pound of these worst sprayed grapes, including the skins, and if all the copper taken in this way were to accumulate in the body, it would require over eight years to accumulate an amount of copper that would, if taken at one dose, be considered dangerous, not necessarily fatal.

"4. As a matter of fact, copper, when found upon sprayed grapes in New York State, exists, not in the form of a sulphate, but in the form of a carbonate or hydroxide, both of which forms are not readily soluble and which would, therefore, be even less dangerous than if present in the form of sulphate of copper. Most of the copper found was on the stems, which people do not eat ; and the rest of the copper was on the outside of the skin of the berries, which most people do not eat.

"5. The results obtained from estimating by chemical analysis the

amount of copper on grapes, which were selected as being the worst sprayed that could be found, therefore, seem to justify the assertion that it is simply an absolute impossibility for a person to get enough copper from eating grapes to exert upon the health any injurious effect whatever."

And, finally, in our present state of knowledge, so far as the toxicology of copper is concerned, it would be most difficult to form a definite opinion. The best authorities differ on the subject, and for many years the question as to the poisonous nature of copper has been discussed with no determinate results. After reading all the testimony pro and con, we may without fear continue to spray our vines and to eat the fruit with a reasonable assurance of safety, at least so long as our appetites are not of Brobdingnagean proportions.

PART II.

INSECTS INJURIOUS TO ORCHARD FRUITS.

THE APPLE.

THE CODLING-MOTH OR APPLE WORM.

(*Carpocapsa pomonella.*)

This, the most insidious of all apple pests, was introduced from Europe over a century ago and is now common wherever the apple is grown, causing greater loss to orchardists than any other insect known. The adult is a night-flying moth with a wing expanse of from one-half to three-quarters of an inch. The fore wings are marked by alternate streaks of brown and gray, and at the outer extremity is a tawny brown spot streaked with light bronze. The hind wings and underparts are light brown and have a satin-like lustre.

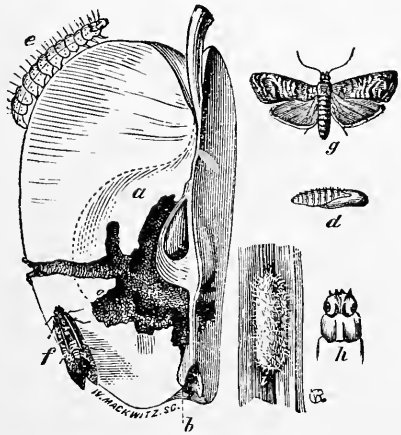


FIG. 38.—THE CODLING-MOTH.

a. Burrow. *b*. Point at which worm entered. *e*. Full-grown worm. *d*. Pupa. *f*. Moth with folded wings. *g*. Moth with expanded wings. *h*. Head and first division of body of worm, enlarged. *i*. Cocoon which encloses pupa. (*Riley*.)

The moths appear about the time the apple trees are blooming. Each female lays about fifty eggs, which are deposited singly in the calyx end of the young apples. The eggs hatch in a week and the little caterpillars begin at once to gnaw through the young fruit to the core. The mature caterpillar is about three-fourths of an inch long.

It now leaves the heart of the apple and, secreted in crevices of the bark or among rubbish beneath the trees, spins a tough but slight silken cocoon in which the pupal period—which lasts for a fortnight—is passed.

At least two broods are believed to develop each season.

Remedies.—An old method for holding this insect in check is to feed all the fallen apples to hogs and to place bands of straw or cotton

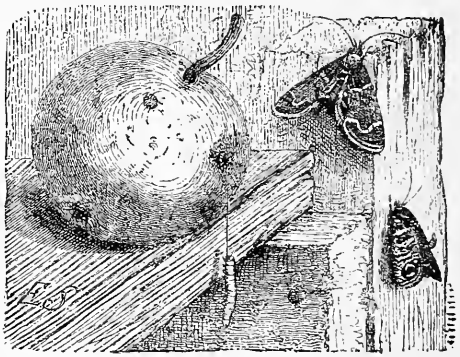


FIG. 39.—APPLE WORM AND MOTH. ABOVE FLOUR-MOTH.

around the trunks of trees as traps for the caterpillars to spin their cocoons under.

By far the most successful means of dealing with the Codling-moth is to spray the trees at the right time with the arsenites, Paris green or London purple. The spraying should be done just after the blossoms have fallen, while the young apples are no larger than peas and are yet in an upright position.

A second spraying should be made in about a week or ten days after the first. Use one pound of poison to from 150 to 200 gallons of water or Bordeaux mixture.

Dr. Riley, in Bulletin No. 23, Maryland Experiment Station,

December, 1893, gives the following formula for Bordeaux mixture :—

Unslaked lime, ...	7 pounds.
Copper sulphate (blue stone), ...	6 "
London purple, ...	½ pound.
Water, ...	75 gallons.

Among carnivorous insect enemies of the Codling-moth are the larvæ of the Two-lined Soldier Beetle and the Pennsylvania Soldier Beetle. Several parasites also infest the pest. The Bluebird, Black-capped Titmouse, Crow Blackbird, and Downy Woodpecker all feed upon the Apple Worm.

THE APPLE-TREE TENT-CATERPILLAR.

(*Clisiocampa americana.*)

A most common native insect, the adult of which is a reddish-brown moth ; the fore wings are tinged with gray and crossed by oblong *dull whitish* stripes. The moths have an expanse of wing of from one and-a-quarter to one-and-a-half inches.

The females lay from 200 to 300 eggs, in wide bands on the smaller twigs of apple and cherry trees, coating them with a glistening glutinous matter, which serves as a protection from moisture.

Fig. 40.—Tent-caterpillar Moth. Natural Size. (*Harris.*)

The eggs are deposited in mid-summer and hatch the following spring. The young caterpillars are about one-tenth of an inch long, blackish in color, and covered with fine gray hairs. Sometimes the eggs hatch prematurely during a warm spell before the buds have begun to unfold, in which case the hardy larvæ feed upon the viscid, glutinous matter which coats the eggs. When the leaves begin to open the caterpillars construct silken webs or tents, usually between the forks of two or more branches, where they remain domiciled when not feeding.

As the caterpillars grow they enlarge the tent by constructing additional layers of web outside the original boundaries. The caterpillars leave the tents to feed twice daily, once in the morning and once in the afternoon. When full-grown the larva is about two inches long with a white stripe along the middle of the back, and on the sides are little irregular yellowish or whitish lines and spots of pale blue.

The body is thinly covered with whitish hairs. The caterpillars now leave the tents and search for suitable shelters about fences and fallen limbs, or even within the tents, and spin oblong whitish silken cocoons intermingled with a yellowish sulphur-colored powder.

The moths emerge in from three to four weeks; after pairing they lay the eggs for another brood and die.

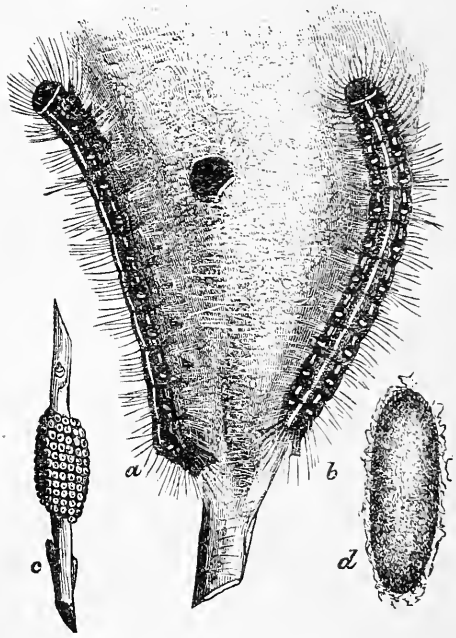


FIG. 41.—THE TENT-CATERPILLAR.

a, Full-grown caterpillar. *c*. Egg-mass on twig, with gummy coating removed. *d*. Cocoon in which the larva pupates. Natural size. (*Riley.*)

Remedies.—The clusters of eggs being conspicuous when the branches are bare in winter may be easily cut off and burned. After the caterpillars have hatched in spring and the tent is spun, infested branches may be destroyed by applying a lighted torch, or better, by pruning and burning. In either case the operation should be performed early in the morning before the caterpillars have left the tents

to feed, or in the evening after they have returned. Or, the leaves at this season may be sprayed with Paris green or London purple and water, using one pound of either poison to from 150 to 200 gallons of water.

CANKER-WORMS.

Two species, Spring (*Paleacrita vernata*) and Fall Canker Worms (*Anisopteryx pometaria*) injure fruit and shade trees; both are much alike in appearance and habits and the injuries done by both species are similar.

The Spring Canker-worm.—The moths emerge from the ground very early, sometimes before the snow is gone. The females are wingless. They crawl up the trunks of trees and pair with the male moths, which are of a pale ash color.

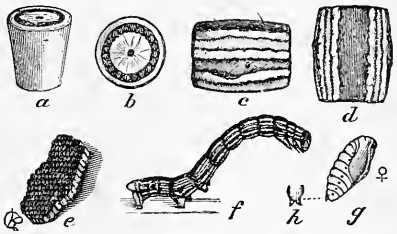


FIG. 42.—CANKER-WORM.
c. Enlarged joint, side view. *d*. The same, back view, showing markings. *e*. Eggs. *f*. Larva. *g*. Pupa. (*Riley*.)

The females then crawl over the branches, depositing their eggs in crevices of the bark; the eggs hatch about the time the buds are unfolding.

The young caterpillars, very commonly known as "measuring worms," "loop worms," "inch worms," etc., feed upon the leaves for several weeks and when full-grown are about four-fifths of an inch long, dark brown in color, with five lighter lines extending lengthwise along the body. The caterpillars have the habit of suspending themselves from trees by a silken thread. When full-grown they let themselves down to the ground by this means and burrow to the depth of three or four inches in the earth, where a silken cocoon is spun in which the pupal period is passed.

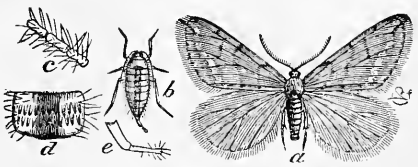


FIG. 43.—SPRING CANKER-WORM.
a. Male moth. *b*. Female moth, natural size. *c*. Joints of her antennæ. *d*. Joint of her abdomen showing the spines. *e*. Her ovipositor, enlarged. (*Riley*.)

A few moths emerge in the fall and lay their eggs, but the insects

mostly remain in the pupal stage until spring when the moths emerge, ascend the trees and the eggs are laid. The females are of a pale ash color like the males.

The Fall Canker-worm resembles the preceding species in habits and appearance and in the character of its depredations to fruit and shade trees. The moth emerges from the ground late in the fall and the wingless females crawl up the trees where they are joined by the males. After mating, the eggs are deposited in regular masses in exposed situations on the twigs and branches of trees.

The eggs hatch about the time the leaves are unfolding in spring. The full-grown larvæ are nearly an inch long and vary in color from greenish yellow to dark brown, with pale longitudinal stripes along the body.

FIG. 44.—FALL CANKER-WORM.

a. Male moth. *b*. Female moth, natural size. *c*. Joints of her antennæ. *d*. Joint of her abdomen, enlarged. (*Riley*.)

At maturity the larvæ descend to the ground, either by crawling down the trunks of the trees or by suspending themselves by means of silken threads from the branches. They burrow into the earth, spin a silken cocoon in which the pupal period is passed, emerging as adult moths in the autumn.

Remedies.—Prof. C. H. Fernald, Hatch Experiment Station. Bulletin 20, January, 1893, says:

"As the females are wingless and pass their transformations underground, and are obliged to crawl up the trunks of the trees to deposit their eggs, one method is to prevent their ascent by putting bands of heavy paper around the trunks, and painting them with some sticky preparation, as printer's ink, or tar softened with oil.

"Another method is to put a trap of zinc or tin around the trunks of the trees in such a manner as to prevent the females from ascending the trees. Care must be taken in putting the bands and traps around the trees to have them fit so tightly that neither the female moths nor the newly-hatched larvæ can find a passage beneath.

"Probably the most effectual method is to shower the trees with Paris green in water as soon as the eggs have hatched in the spring."

Spray infested trees with a mixture of one pound of Paris green to 200 gallons of water as soon as the larvæ begin to appear. Birds and predaceous insects prey upon both species of Canker Worms.

THE BUD-MOTH.

(*Tmetocera ocellana.*)

Attacks the apple, pear, peach, plum, quince and cherry, but is most destructive to the apple.

This pest is closely allied to the codling-moth, which the adult resembles in form and size, differing, however, in coloring, in structure and in life history.

It is in the larval or caterpillar stage that this insect is most familiar to farmers and fruit growers. The larvæ, after hibernating through the winter, appear as small brown caterpillars early in the spring. Usually about May first, or as soon as the buds begin to open, the little brown caterpillars appear on early varieties, and a week or two later begin their work of destruction on later fruits.

When full-grown the larva is about a half inch long, and is of a cinnamon-brown color, with shining black head. The larva forms a tube by rolling up one side of a leaf, or the remnant of two or more partially-

FIG. 45.—ADULT BUD-MOTH.

FIG. 46.—LARVA ENLARGED. —(*Slingerland.*)

devoured leaves, which are securely fastened together with silken threads. This little chamber forms the cocoon, which the insect lines with a thin, closely-woven layer of silk.

The period of pupation lasts for ten days. The moths begin to appear early in June in the Northern States, where the pest is single brooded.

Prof. Comstock's notes, taken while he was United States Entomologist (1879), show that the larvæ pupated in the vicinity of Washington, D. C., as early as May 19th, and the moths began emerging May 29th. It is, therefore, possible that in the latitude of Washington and in the Southern States there are two broods each season.

This insect has a number of parasitic and other enemies, which aid in holding it in check. It is devoured by many insectivorous birds, and has a formidable foe in the mud-wasp (*Odynerus catskillensis*).

Remedies.—"It is not practicable to try to check this pest," says

Mr. M. V. Slingerland, Assistant Entomologist Cornell Experiment Station, Bulletin 50, March, 1893), "in either the adult or egg stages, or while it is in hibernation as a half-grown larva. Undoubtedly it can be checked somewhat by spraying in July when the larvæ are at work on the under side of the leaves. But the best time to combat the pest the most profitably and successfully is in the spring, when a little poison can be easily sprayed upon the opening buds; and thus the little larva, hungry from the long winter's fast, will be quite certain to get the fatal dose at its first meal."

The same investigator advises fruit growers to spray infested trees with Bordeaux mixture and Paris green combined, using the Paris green at the rate of one pound to 200 gallons of Bordeaux mixture. Or Paris green may be used alone at the rate of one pound of the poison to 250 to 300 gallons of water. The first application should be made in the spring, just as the buds are opening, and a second spraying should follow a week or ten days later, or before the blossoms open. Do not spray the trees when in bloom.

THE FALL WEB-WORM.

(*Hyphantria cunea.*)

This insect is widely distributed over the United States, being single brooded at the North; but in the Southern States there are two broods each year.

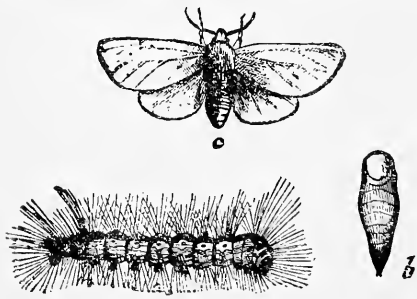


FIG. 47.—THE FALL WEB-WORM.
a. Larva. *b*. Pupa. *c*. Adult moth, natural size.

The webs are conspicuous in late summer and early autumn on apple, pear and cherry trees; indeed, the unsightly webs of this pest are common on a large number of fruit and shade trees, and ornamental plants.

The adult is a pretty snow-white moth or "miller." Sometimes the front wings are spotted with black or dusky dots, but the general color of the mature moth is pure white.

The eggs are deposited on the under side of the leaves in May or June. The caterpillars are soon out and begin at once to spin a com-

mon web in which the colony lives, feeding upon the pulpy parts of the leaves. When the leaves enclosed by the web are all eaten, other twigs or branches are inclosed by extending the web.

The young worms have black heads, are pale yellow in color, and are thinly covered with hair. The full-grown caterpillars are about an inch long, densely covered with long, slender, yellowish hairs, and are of a greenish-yellow color. The head and legs and a narrow strip along the middle of the back are black, and the under-sides are dusky brown.

When full-grown they leave the web, descend to the ground, and burrow just beneath the surface, or find a retreat under refuse or litter, where they spin a light silken cocoon, and enter upon the pupal stage. In the South there are two broods yearly, the second appearing in August or September.

Remedies.—In combating insects which injure so wide a range of plants as is the case with the Fall Web-worm, suppressive measures should be begun with the first appearance of the pest, and should be continued without intermission so long as the danger lasts. Infested twigs should be cut off and burned, or spraying with the arsenites should be resorted to.

Carnivorous insects and parasitic fungi help, in a measure, to hold this insect in check.

THE LESSER APPLE-LEAF ROLLER.

(*Teras minuta.*)

Three broods of moths appear during the year, two of which are bright orange yellow, while those of the third brood are reddish gray.

The eggs are laid in spring on the opening leaves of the apple, cranberry, and some other plants. The larva, which is a greenish-yellow worm, covered with hair, soon appears, and proceeds to feed upon the foliage, out of which it rolls a covering for passing the period of pupation. The moth emerges a week or two later. These lay eggs for another brood, the adults of which appear during August, and are of the same orange-yellow color. The third brood,

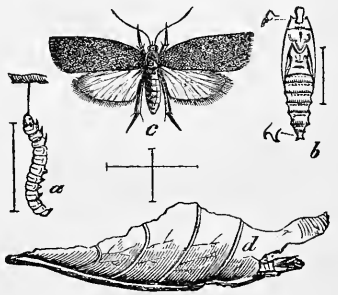


FIG. 48.—LESSER LEAF ROLLER.
a. Larva. *b*. Pupa. *c*. Moth. *d*. Rolled leaf. (*Riley.*)

developed from the eggs of these, pass the larval and pupal stages during September, and emerge as reddish-gray moths in October. They pass the winter hidden away under rubbish, and deposit their eggs the following spring.

Remedies.—Spray with Paris green or London purple, using one pound of poison to about 200 gallons of water.

THE YELLOW-NECKED APPLE-TREE CATERPILLAR.

(*Datana ministra.*)

The moths have light-brown wings, striped with deeper shades of the same color. The eggs are laid during June or July, and the larvæ attain full growth in from five to six weeks from hatching. The full-grown caterpillars descend to the ground and burrow in the earth,

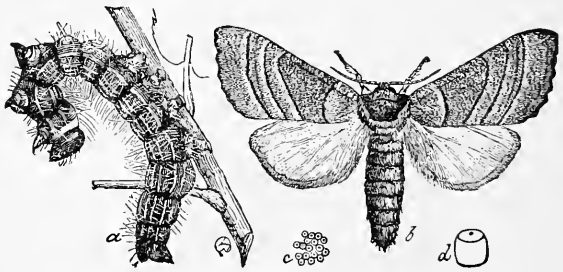


FIG. 49.—YELLOW-NECKED CATERPILLAR.
a. Larva. *b*. Moth. *c*. Eggs. *d*. Magnified egg. (*Riley.*)

where they spend the pupal stage, emerging as moths the following summer.

Remedies.—This insect rarely becomes troublesome, so numerous are its bird and insect enemies. When these do not hold it in check, Paris green or London purple may be sprayed on infested trees as directed for the Lesser Apple-leaf Roller.

THE LEAF CRUMPLER.

(*Phycis indigenella.*)

The adult is a small gray moth, which deposits her eggs on the apple, cherry, plum, quince, and crab-apple.

The larvæ are small brown worms that feed on the leaves, constructing cylindrical silken cases that afford them concealment when not engaged in feeding. As the worms increase in size, bits of partially-eaten

leaves are drawn about the openings of their tubular abodes, forming quite an accumulation of partially-eaten foliage. At the approach of winter the cases are made fast to twigs or branches by silken threads, and the larvæ retire within the cells until the return of spring. They then become active again, destroying both leaves and flower buds, and continue growing and feeding until June, when the pupal stage is

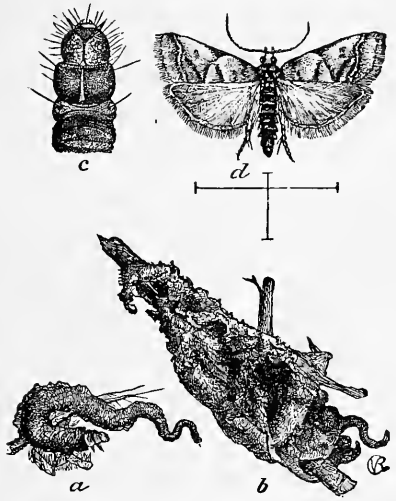


FIG. 50.—LEAF CRUMPLER.

a. Larval case. *b*. Larval case with dead leaves. *c*. Front part of larva. *d*. Moth, magnified. (*Riley*.)

entered upon within the tubular silken cases which served as domicils for the larvæ.

The moths emerge a fortnight later.

Remedies.—Parasitic insects, of which there are several species, help to hold this insect in check. The larval cases may be picked off in winter and burned, but the most practical method of dealing with this pest is to spray with the arsenites, Paris green or London purple, using one pound of the poison to about 200 gallons of water.

THE APPLE-LEAF SKELETONIZER.

(*Pempelia hammondi.*)

The adult is a small, purplish moth with two light bands upon the fore-wings, as seen in figure 51.

Two broods are believed to appear each season, the second being by far the most numerous and destructive.

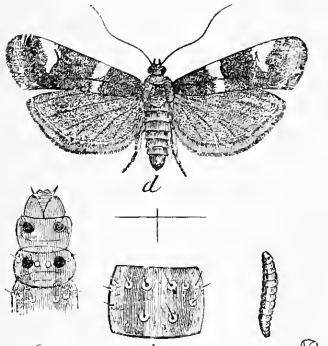


FIG. 51.—LEAF SKELETONIZER.

a. Larva. *b*. Part of back, magnified to show markings. *c*. Head and front part of larva, magnified. *d*. Moth, magnified. (*Riley.*)

The larva is a small, greenish or brownish worm about half an inch long, with a few short scattered hairs upon the body. The worm feeds upon the pulpy portion of the leaves, and spins over itself a light silken web on the upper side of the leaf, underneath which it feeds. Pupation takes place in mid-summer in cocoons formed on the leaves, and the imago appears two weeks later. The second brood of larvæ soon appear; these hibernate through the winter and emerge as moths the following spring.

Remedies.—This insect is generally most destructive in young orchards or in the nursery. Spray with Paris green or London purple, using one pound of the poison to from 200 to 250 gallons of water.

THE ROUND-HEADED APPLE-TREE BORER.

(*Saperda candida.*)

The adult beetle is readily recognized by two longitudinal white stripes between three of chestnut-brown along the back. It appears early in summer, but is not likely to be seen or known by the farmer, since it flies only by night and remains hidden away and inactive through the daytime. The female deposits her eggs on the tree-trunks, in an opening in or under the bark, close to the ground. The eggs hatch in a few days, and in less than a fortnight the young grub begins to gnaw its way into the sap-wood. The summer and autumn

are spent feeding upon the sap-wood, and as winter approaches the grub burrows below the surface of the ground and hibernates until spring, when it again gnaws its way upward, feeding on the sap-wood and inner bark. The second winter is spent like the first, and with the coming of spring the grub burrows deeper into the trunk, sometimes boring completely through the tree into the bark on the opposite side. The borer completes its injurious work before or during the commencement of the third winter, but remains inactive in the larval state until spring, when it becomes a pupa. After a fortnight spent in the quiescent pupal stage, it emerges as the adult beetle.

The presence of the borer may be generally detected, more especially in young trees, from the dead bark turning black and cracking under the holes through which some of the castings of the grub are pushed

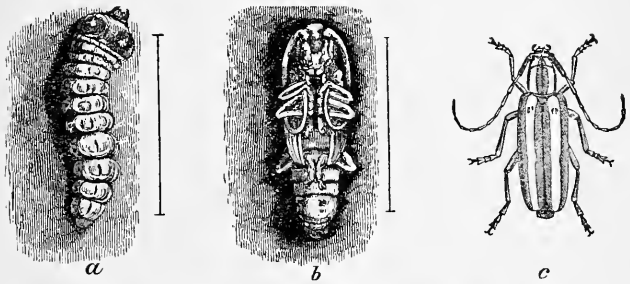


FIG. 52.—ROUND-HEADED APPLE-TREE BORER.
a. Larva. *b*. Pupa. *c*. Beetle. (*Riley*.)

out. The round-headed borer operates altogether near the base of the tree. The full-grown grub is about an inch long, whitish-yellow, with chestnut-brown head and jaws of deep black.

Remedies.—Preventive measures are the best. Thoroughly scrub the trunks and larger branches of the trees with carbolic acid soap wash. (See page 47.) This should be done in May or early in June. Keep the base of the trees free from rubbish of all kinds; and as alkaline washes are repulsive to the beetles, each tree should be smeared with the soap-wash about the base of the trunk.

Examine the trees again in the fall, and wherever the young worms can be found they should be cut out and destroyed.

THE FLAT-HEADED APPLE-TREE BORER.

(*Chrysobothris femorata.*)

The beetle is greenish-black in color, flat instead of cylindrical in form, as in the case of the insect just discussed, and does not fly by night. It appears in the latter part of May, or early in June, and attacks the apple and peach, and is believed to injure several forest trees. The eggs are deposited early in summer in crevices and under scales of the bark on all parts of the trunk and larger limbs.

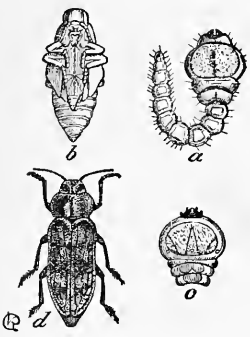


FIG. 53.—FLAT-HEADED BORER.
a. Larva. *b*. Pupa. *c*. Front of larva, lower side. *d*. Beetle. (*Riley.*)

The larva is pale yellow in color, without feet, and the head is greatly enlarged and flattened, while the rest of the body slightly tapers toward the posterior end.

The grub lives for one year in the tree, boring an oval-shaped hole twice as wide as high.

Remedies.—Treat the same as for the Round-headed Apple-tree Borer.

THE APPLE-TWIG BORER.

(*Amphicerus bicaudatus.*)

A small, dark-brown beetle, which bores into the twigs, just above a bud or joint, where the insect remains for the winter. The injured twig is usually broken off by the wind, or if it remains attached to the limb the leaves turn brown and the branch generally dies.

Remedy.—The habits and life history of this insect, both in the larval and adult states, are but little known. Prune the infested branches and burn the prunings.

THE APPLE MAGGOT.

(*Trypeta pomonella.*)

The larva of a native two-winged fly that appears early in summer and deposits her eggs under the skin of the apple. The eggs hatch in a few days, and the maggots tunnel indiscriminately through the young fruit. When full grown the larvæ are light greenish or white, and about one-fourth of an inch long.

They now leave the apple and retire to the soil where the pupal stage is passed, emerging the following summer as flies.

Remedies.—Fortunately this insect has not heretofore seriously injured cultivated fruits, except in a few States, and in these the pest has been confined to rather limited areas, and has shown marked partiality for summer and autumn varieties of fruit. It, however, commonly infests our wild crab-apples and haws in all parts of the country.

It is not possible to destroy the apple maggots by the use of arsenites or other poisons. The affected fruit generally ripens prematurely and falls to the ground, and hence may be readily destroyed or fed to hogs or other animals.

THE APPLE CURCULIO.

(*Anthonomus quadrigibbus.*)

This insect, which has long infested our native crab-apples and haws, is a snout beetle, nearly related to the plum curculio, but differing from it in having a larger snout and broader body. There is but one brood each year, the adult beetles hibernating through the winter, and the female depositing her eggs in holes drilled in young apples in

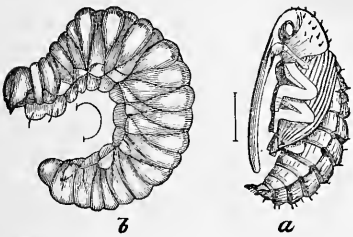


FIG. 54.—APPLE CURCULIO.
a. Pupa. *b*. Larva, magnified. (*Riley*).

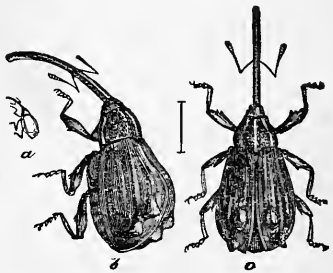


FIG. 55.—APPLE CURCULIO, MAGNIFIED. (*Riley*.)

the spring. The eggs soon hatch, and the young grubs feed upon the pulp, burrowing to the cores, where they remain for from four to five weeks.

Pupation takes place within the cavity of the apple. In about three weeks the pupa changes to the perfect beetle and eats its way out of the fruit.

Remedies.—Windfalls from infested trees should be gathered up and fed to hogs or destroyed. Since the adult beetle bores into the

young apple, both for the purpose of feeding and depositing its eggs, the use of arsenites should be resorted to whenever this pest appears in considerable numbers. Spray with poisons, as directed for the Codling-moth. (Page 58.)

THE OYSTER-SHELL BARK LOUSE.

(*Mytilaspis pomorum.*)

This is one of the most troublesome and destructive insects with which the orchardist has to deal. Its ravages are not confined to the apple-tree alone ; it infests the pear and plum, and also the currant.

The female is only capable of locomotion for about three days, after which she becomes immovably fastened to the tree. The eggs, which are yellowish or whitish, hatch in May, and the young lice, scarcely visible to the naked eye, crawl over the bark for two or three days, then, fixing their beaks into the bark far enough to reach the sap, remain fastened to the tree for life. They continue to feed upon the

FIG. 56.—OYSTER-SHELL BARK LOUSE.

sap of the tree, and by the end of the season have reached maturity and secreted the scaly covering under which their eggs for the first spring brood have been deposited.

Remedies.—The young lice are easily destroyed in spring by spraying with kerosene emulsion.

The emulsion should be well made, with no free oil floating on the surface, and to be effective must be very thoroughly applied. In old orchards the trees should be scraped in winter or early spring and then scrubbed with carbolic acid and soap solution. (See page 47.)

THE WOOLLY APHIS.

(*Schizoneura lanigera.*)

Two forms of this insect are known, one attacking the trunks and limbs and the other infesting the roots of trees. The white, fluffy masses on the limbs, which serve as a covering for the small, yellowish lice concealed beneath, are secreted by the insect and serve as a partial protection from its foes, the Ladybird Beetle and a small parasitic fly.

The subterranean insects may be readily detected by the knot-like excrescences found on the rootlets. These insects injure trees by sucking out the sap, and are most liable to infest young orchards or old ones in an unhealthy condition.

Remedies.—The trunks, limbs, and twigs of trees should be sprayed several times during summer with kerosene emulsion. At this season the Woolly Aphis, like other aphides, gives birth to living

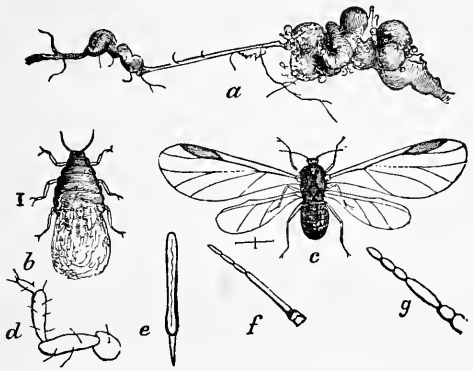


FIG. 57.—WOOLLY APHIS.

a. An infested root. *b*. The larva; color brown. *c*. Winged adult; colors black and yellow. *d*. Its legs. *e*. Its beak. *f*. Its antenna. *g*. Antenna of the larva, all highly magnified. (*Riley*.)

young, and multiplies with the characteristic rapidity of these insects. To destroy the subterranean insects, tobacco dust or tobacco stems should be dug in about the roots, or the soil about the bases of the trees should be saturated with kerosene emulsion, and then be well drenched with water.

THE BUFFALO TREE-HOPPER.

(*Ceresa bubalus*.)

A small, greenish insect, not over one-third of an inch long, which is often observed on apple and pear trees late in summer or early in autumn.

The eggs are deposited at this time in the upper parts of the twigs of fruit and shade trees, and hatch late in the following spring.

The young hoppers, which are greenish-yellow, resembling the adults, insert their beaks into the bark and feed upon the sap.

Remedies.—Parasitic enemies which destroy the eggs are believed to greatly aid in holding this insect in check. It is rarely very injurious to fruit trees. Spray with kerosene emulsion just after the eggs hatch in May, or cut off infested twigs and burn.

THE TWIG GIRDLER.

(*Oncideres cingulatus.*)

The adult beetle is brownish-gray, with a broad band of gray on the wing-covers. In Pennsylvania the pest does most damage to young hickory trees, but occasionally it is found working on the branches of the elm, apple, plum, pear and persimmon.

The eggs are laid in late summer and during autumn. The female punctures a branch or twig just beneath or near a bud, and into each puncture, several of which are often made in the same branch, she deposits a small, whitish egg. She then proceeds to cut a groove around the branch at a point below where the lowest egg has been inserted. The insect cuts through the bark and into the wood, completely girdling the stem, which soon dies, and is quite often broken off by the wind. The eggs soon hatch into small, white grubs, which feed for a time on the substance of the dead branches and then hibernate for the winter in neat burrows under the bark.

In addition to the trees already named, this insect injures the American linden, peach and quince, and in the South has done serious damage to orange and pecan groves.

In the Northern States the Twig Girdler is most destructive to hickory, especially to saplings from 1 to 2 inches in diameter. The writer has frequently observed this insect at work in Bucks County, Pa., and especially in southern New Jersey, where it does very considerable damage to young hickory. In these sections the girdling is done after the eggs have been inserted in the stem, twig or branch; the insect seems to have a preference for saplings, which are usually girdled from 1 to 5 feet from the ground.

Remedies.—Mr. M. V. Slingerland, in the *Rural New Yorker*, November 27th, 1893, says: "It is a very easy pest to combat. All that is necessary is to gather and burn the girdled dead branches, whether yet on the trees or on the ground, in the fall, winter or spring, thus destroying the grubs they contain."

APPLE APHIS.

(*Aphis mali.*)

These little green lice often completely cover the leaves and twigs of apple trees during spring and early summer. The eggs, laid by winged females in the previous autumn, hatch as soon as the leaf-buds begin to unfold, and the lice continue breeding until July, when they migrate in large numbers to more succulent plants. With the coming of autumn the winged females return to the apple trees and deposit the eggs, from which the colonies of the succeeding spring will be hatched.

Remedies.—What has been said regarding the general treatment of aphides applies to these insects. Kerosene emulsion, lye-washes and decoction of tobacco, as prescribed on pages 45, 46, should be thoroughly applied as soon as the young begin to hatch.

GENERAL TREATMENT OF APPLE ORCHARDS.

Just as soon as the blossoms have fallen, spray the trees with Paris green and water, using from 5 to 6 ounces of the poison to 100 gallons of water,—and don't forget the glucose, molasses, or flour paste as directed on page 42. Where orchards are affected by scab or rust, it is well to combine with the poison a certain proportion of Bordeaux Mixture. See pages 50 and 58.

Applications of the insecticide, or combined insecticide and fungicide, should be repeated two or three times at intervals of about ten days. Early in summer the trunks and larger branches should be washed with Corrosive sublimate and Carbolic Acid wash. See pages 47 and 50.

THE PLUM.

THE PLUM CURCULIO.

(*Conotrachelus nenuphar.*)

This, the most destructive insect enemy of the plum grower, is a native snout-beetle of wide geographical distribution throughout the United States.

The mature beetle is about one-fifth of an inch long, dark-reddish, or grayish-brown with an elongated black hump on the middle of each wing-case; behind the hump, which is knife-shaped, are broad bands of dull yellow with white markings in the middle. The adult beetle has a stout body with roughened, uneven surface, and like others of

the group to which it belongs, is provided with a curved snout or beak projecting downward from the eyes with the jaws at the extremity.

There is but one brood each year; the mature beetles leave their winter hiding places, under the loose bark of trees, from under heaps of rubbish or other sheltered retreats, appearing in spring about the time the trees are in bloom.

The female lays from fifty to two hundred eggs, but carefully deposits but one egg only in each plum.

This is done by first puncturing the plum with her beak, then inserting the egg and thrusting it to the extremity of the cavity with her snout. Finally she cuts the crescent shaped groove in front of the puncture, thus undermining the egg and so deadening the adjacent tissue as to prevent the growth of the plum from crushing the oblong white egg concealed within.

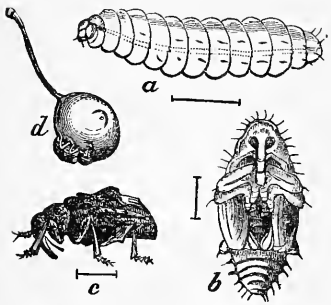


FIG. 58.—PLUM CURCULIO.
a. Larva. *b*. Pupa. *c*. Beetle, magnified. *d*. Plum showing crescent mark. (*Riley*.)

The eggs hatch in three or four days in mild weather, and the young grubs begin to feed upon the pulp of the plum. The grubs are full grown in from three to five weeks, by which time the infested and prematurely ripe fruit has generally fallen to the ground. The larvæ now leave the plums, burrow into the earth and enter the pupal state, emerging as perfect beetles in about six weeks. This insect also attacks the nectarine, apricot, pear, peach, cherry, apple and plum.

Remedies.—Spraying with Paris green or London purple and water, using one pound of the poison to two hundred gallons of water, is undoubtedly effective if the application is made as soon as the fruit begins to set and before the beetles have eaten into the forming fruit. Many conflicting reports have been published, regarding this method of treatment, but when due care is exercised to make the application at the proper times there can be no question of the efficiency of the treatment. The writer uses a much weaker mixture, usually from one to two ounces of Paris green to 35 gallons of water, and sprays the trees as soon as the petals fall, repeating the sprayings two or three times at intervals of about ten days.

Jarring the trees to dislodge the insects is practiced by many ex-

perienced orchardists. This is done by striking the trees or limbs on which the curculio are feeding, with a padded mallet. Sheets are spread under the trees to collect the falling insects. Large orchardists use a frame in the form of an umbrella covered with strong cloth or canvas, and mounted on wheels. This is wheeled from tree to tree, the curculio jarred down and destroyed.

This insect is subject to parasitic enemies, but these do not appear to be of much importance in reducing the numbers of the pest.

THE PLUM-TREE BORER.

(*Aegeria pictipes.*)

The adult is a moth resembling the Peach-tree Borer in habits and life history, to which it is nearly related.

The larva tunnels into the bark and sap-wood of the trunk and branches. This insect also infests the cultivated and wild cherry.

Remedies.—When found in injurious numbers, which is rarely the case, the larvæ should be cut out with a knife, and the trunks and larger limbs be painted with soft soap and carbolic acid wash, as directed on page 47.

THE PLUM GOUGER.

(*Coccotorus prunicida.*)

The adult is also a small snout beetle, about the size of the plum curculio, but differs from it in being of a brownish or yellowish color, with the back smooth. This insect is rarely found in the east, but west of the Mississippi River is widely distributed and most destructive.

It appears about the time the trees are in bloom, and as soon as the fruit begins to set, tunnels into the young plums, excavating a cavity in which the eggs are laid.

The larva hatches in a few days and burrows into the pit, the contents of which are eaten.

Before entering upon the pupa stage the full-grown larva bores an outlet through the wall of the pit, through which the insect escapes after completing its transformations.

The plum gouger is single-brooded, the adult beetle hibernating through the winter.

Remedies.—This insect has some natural enemies which help to hold it in check.

We believe that spraying with the arsenites or jarring the trees, as

practiced in combating the plum curculio, page 75 will be found equally applicable to this insect.

THE PLUM TREE APHIS.

(*Aphis prunifolii.*)

As soon as the buds begin to expand in spring these little dark-colored lice appear and begin to sap the substance of the tender foliage. Several species are known to infest the plum, but all are much alike in life history and habits.

Like the apple-tree aphis, the species that attack the plum possess marvelous fecundity and are not only oviparous, but bring forth living young. If not checked they multiply in such numbers that the leaves soon become curled or withered, and drop to the ground.

Remedies.—Preventive measures should be taken on the first appearance of the lice.

Kerosene emulsion applied with a stiff brush to the trunk and larger limbs and sprayed with a force pump and nozzle over the foliage is a most effective and easily applied remedy.

Spraying should begin as soon as the lice appear, and before they are afforded protection by the curling of the leaves.

General Treatment.

The Peach-tree Borer, and Flat-headed Apple-tree Borer at times attack the plum.

Treatment should be the same as directed for the peach and apple. If plant lice appear in spring as is frequently the case, spray with kerosene emulsion, or if the trees are infested by the Grape-vine Flea-beetle, Cherry or Pear slug, or other foliage eating insects, spray with Paris green.

The general treatment of the plum in spring and summer should be the same as that prescribed for the apple. A good quality of Paris green should be used, and never stronger than 6 ounces to the 100 gallons of water. London purple has proved unreliable with the writer, and it frequently injures the tender foliage of the plum. Use a fine quality of Paris green and a nozzle throwing a very fine mist-like spray.

THE PEAR.

PEAR-TREE PSYLLA.

(*Psylla pyricola.*)

The presence of this depredator is usually first made evident in the lessened vitality and sickly appearance of the trees.

The leaves turn yellow, the young fruit makes but little growth, and by mid-summer both the leaves and the stunted, half-formed fruit have mostly fallen to the ground.

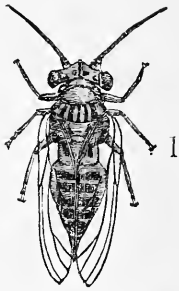


FIG. 59.—PEAR-TREE PSYLLA. (*Slingerland.*)

A sweet, sticky, water-like fluid, called honey-dew, covers the branches, and appears to exude from the twigs and trunks of the trees. This fluid appears on the infested trees soon after the leaves expand; at first it is clear and colorless like water, but soon becomes covered with a black fungous growth, which gives the trees an appearance of having been treated with a thin coating of black or slate-colored paint.

This honey-dew is not, as has been supposed, the sap of the tree exuded through the punctures made by the feeding insects. The nymph or immature insect feeds exclusively on the sap, and the supposed exudation from the tree has passed through the body of the insect.

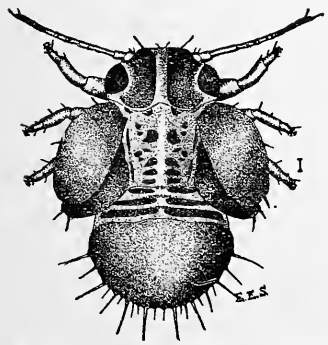


FIG. 60.—FULL GROWN NYMPH, DORSAL VIEW. (*Slingerland.*)

The body of the adult is crimson, marked with broad, black bands across the abdomen; the wings are almost transparent, and when the insect is at rest, slope like a roof over the sides of the body. The adult resembles a miniature Cicada or Harvest-fly.

Mr. M. V. Slingerland, Bulletin 44, October, 1892, Cornell Agricultural Experiment Station, found that a single nymph, isolated in a cage, secreted at least four

drops, that is, four minims of the fluid before reaching the adult stage. At this rate fifteen nymphs would secrete one dram of honey-dew.

Remedies.—The strongest-known insecticides do not destroy the eggs. The young nymphs are, however, very susceptible to kerosene emulsion, and their habit of feeding in the leaf axils makes the use of the spray most effectual for their destruction.

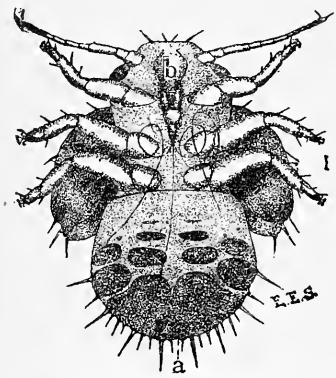


FIG. 61.—FULL GROWN NYMPH, VENTRAL VIEW. (*Slingerland.*)
a. Anus. *b*. Beak.

In experiments at the Cornell Experiment Station, one part of kerosene emulsion in twenty-five parts of water effectually destroyed the nymphs, and two quarts of the dilution was found sufficient for a large dwarf tree.

The time to spray is early in the spring, just after the leaves have unfolded. A second, and even a third spraying should be applied if the nymphs are numerous, or if there has been little rain to wash off the honey-dew.

"Most of the damage," says Mr. Slingerland, in the same Bulletin, "is usually done before June 15th, but spraying after this date will decrease the number from which the hibernating forms are produced; and the orchard may thus be saved from a severe attack the following year."

THE PEAR-TREE BORER.

(*Aegeria pyri.*)

The adult is a small, bluish-black or purplish moth, whose eggs are laid upon the bark of the tree; the larvæ feed on the inner bark or sap wood. This insect does little damage.

Remedies.—The larvæ may be detected on the trunk by the fine sawdust-like castings thrown out of their tunnels. Wherever found, the borers should be cut out and the trunks painted with soft soap and carbolic acid mixture. (See page 47.)

THE PEAR-TREE SLUG.

(*Selandria cerasi.*)

The adult is a four-winged fly with transparent, iridescent wings, the fore-wings being marked with a smoky tinge across the middle. The adult bears a general resemblance to the Rose Slug and Imported Currant-worm fly, to which the Pear-tree Slug is nearly related. The eggs are laid in small incisions made in the skin of the leaf.

In the older seaboard States this insect is very injurious to the quince, plum, and cherry, as well as to the pear.

The larva when full grown is a dark, bottle-green slimy worm, about one-half inch long, having something of the shape of a tadpole (Fig. 62). The slugs feed upon the pulpy substance of the

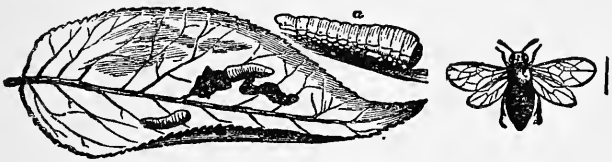


FIG. 62.—PEAR-TREE SLUG.

leaves, and when present in large numbers completely defoliate the trees.

The larvæ reach full growth in about four weeks from hatching.

They then shed the slimy skin and appear as clean, yellowish caterpillars. They now leave the trees and enter the soil, where the pupal stage is passed. A fortnight later the adult emerges. The female fly is a little over one-fifth of an inch long and the male slightly smaller. There are two broods each year in the Northern and Central States.

Remedies.—Pyrethrum, or white hellebore powder, may be dusted over the foliage with a powder bellows, or the trees may be sprayed with decoctions of these insecticides, or with the aqueous mixtures of Paris green or London purple.

THE SCURFY BARK-LOUSE.

(*Chionaspis furfurus.*)

This insect is most destructive in the southern, middle, and central States.

It is a small, reddish-brown louse, found on the trunks and limbs

FIG. 63.—THE SCURFY BARK-LOUSE, ON SECTION OF TWIG. (*Garman.*)

of pear and apple trees. Often in winter the bark of infested trees is literally covered with small, whitish scales, beneath which are concealed the eggs of this pest. These eggs hatch female lice only, which reproduce living young. The eggs usually hatch in May or early in June, and after crawling over the tree for a few days the young lice insert their minute beaks into the bark and suck the sap.

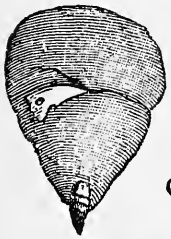


FIG. 64.—THE SCURFY BARK-LOUSE, ENLARGED. (*Garman.*)

Remedies.—Treatment is the same as for the Oyster-shell Bark-louse. (See page 72.)

THE PEAR-LEAF MITE.

(*Phytoptus pyri.*)

A minute insect nearly related to the red spider, so often troublesome on greenhouse plants.

The first appearance of the Pear-leaf mite is indicated by small, reddish spots early in spring on the upper surface of the leaves. This discoloration becomes darker as the season advances, and finally turns black.

The eggs are concealed in these spots, and after hatching, the mites burrow into the tissues of the leaf, feeding upon its substance, and in turn providing for another generation. With the coming of autumn the insects migrate from the dead or diseased leaves to the twigs, and penetrate the leaf scales, where the winter is passed in a dormant condition.

Remedies.—Pruning closely in winter and burning as many of the infested twigs as can be done without injury to the trees, is sometimes resorted to. The pest is a difficult insect to fight, living, as it does, from spring to fall within the tissues of the leaves, and spending the winter concealed under the leafy scales of the buds.

From one to three sprayings with kerosene emulsion in autumn, when migrating to its winter quarters, will probably greatly aid in diminishing the losses from this insect.

OTHER INSECTS INFESTING THE PEAR.

The Plum curculio and Codling-moth are also most destructive to the fruit of the pear. Spraying with the arsenites, as directed for these insects, is the proper treatment.

General treatment of the pear should be the same as for the apple.

THE CHERRY.

THE FLAT-HEADED CHERRY-TREE BORER.

(*Dicerca divaricata.*)

The adult is a copper-colored beetle about four-fifths of an inch long. The female deposits her eggs on the trunk of both the cultivated and wild cherry, and the larvæ tunnel into the sap-wood, which forms their food.

This pest is closely related to the Flat-headed Apple-tree Borer, which it resembles in habits and life history.

Remedies.—Treatment should be the same as for the Round-headed Apple-tree Borer. (See page 69.)

THE MAY BEETLE.

(*Lachnosterna fusca.*)

The adult is dark chestnut-brown in color, the head and thorax often nearly black and the breast covered with light yellowish hairs.

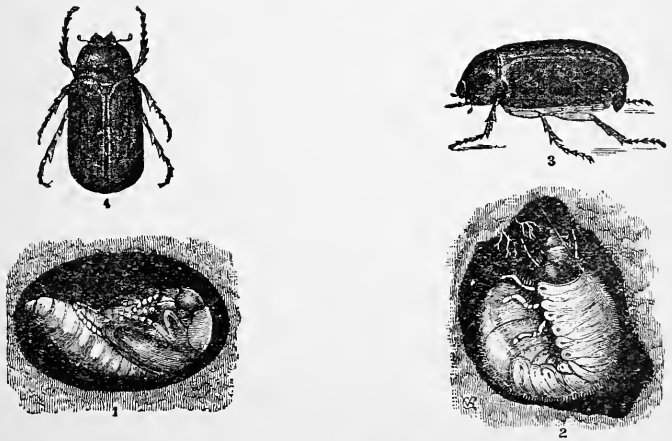


FIG. 65.—MAY BEETLES.
1. Pupa. 2. Larva. 3 and 4. Adults. (*Riley.*)

The body is oblong, oval, and from three-fourths to an inch long, and about half an inch in diameter. The beetles, which are voracious feeders, appear in May or June, and feed by night upon the fruit and leaves of different trees, sometimes completely denuding them of their foliage before the presence of the insect is discovered.

The females lay from 40 to 50 eggs which are deposited among grass roots in a ball of earth.

FIG. 66.—MAY BEETLES AT NIGHT.

The eggs hatch in about a month and the larvæ, which are very small, feed during the first year on the rootlets of various plants. In the second year the grubs work near the surface; eating all sorts of roots, and doing great damage to cultivated crops as well as to pasture lands.

The grubs reach full growth in the third year. They are then soft, dirty white worms with a horny head of a dark brown or mahogany color.

The grubs now construct egg-shaped cocoons or chambers of earth and change to pupæ. The mature beetles emerge in the spring, live for about three weeks, during which time they mate, and the eggs are laid for a succeeding generation.

Remedies.—The underground life of the larva makes the pest exceedingly hard to destroy.

Crows, robins, blackbirds and blue-jays feed upon the grubs; swine and domestic fowls when allowed to roam over infested fields destroy the pest in large numbers.

The grubs are also eaten by moles and skunks, and are subject to the attack of a white fungus which is frequently found growing in two

long, horn like appendages protruding from each side of the head. Grubs found with these horn-like processes should not be killed, but should be permitted to live and propagate the parasite.

In lawns of small area, kerosene emulsion may be used, but the soil must be drenched in order to reach the grubs.

For the adult beetle, spraying the trees with Paris green or London purple should be resorted to.

THE CHERRY APHIS.

(*Myzus cerasi.*)

In appearance, habits and life history the cherry aphis is very similar to apple and plum aphides. The lice appear during May and June, and at once begin to suck the sap of the unfolding buds.

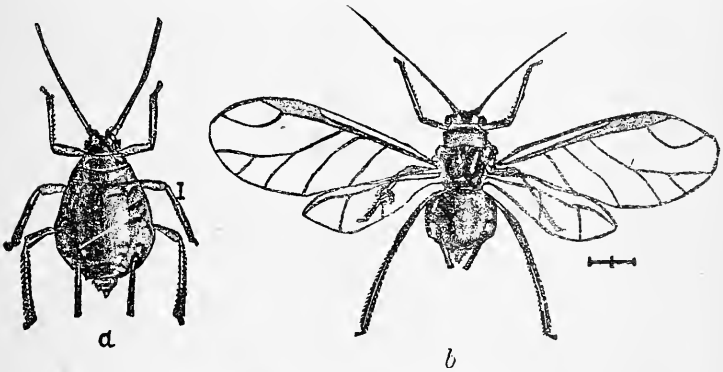


FIG. 67.—CHERRY APHIS.
a. Wingless female. *b*. Winged female, magnified. (*Weed.*)

In about a week they are full-grown, and begin giving birth to living young; these as quickly mature, and are just as prolific in reproducing their kind.

The early spring broods are mostly wingless, but during summer the winged forms appear, and by July these begin to migrate to some other plants, on which they continue to breed through the summer. In autumn a winged brood appears, which returns to the cherry, and the eggs for the following spring brood are laid.

Remedies.—This species, like the apple and plum aphis, is held in check to some extent by predaceous and parasitic enemies. Spraying with kerosene emulsion, as directed for similar pests, is the best artificial remedy.

THE CHERRY-TREE LEAF-ROLLER.

(*Cacœcia cerasivorana.*)

This is the caterpillar of a small, brown moth, which lays her eggs on the twigs of both the wild and cultivated cherry. The caterpillars fasten the leaves together and live on the substance of the leaves forming the nest.

Remedies.—Spraying with either kerosene emulsion or the arsenites is uncertain, since the caterpillars find concealment in the folded leaves of the tent-like structure. The infested twigs are, however, made conspicuous by the nests, and should be cut off and burned.

OTHER INSECTS INFESTING THE CHERRY.

The Plum curculio and the Pear-tree slug are both destructive to the cherry. The remedies used for destroying these pests are equally applicable in the treatment of the cherry.

General Treatment of the cherry in spring and summer should be the same as for the apple.

THE PEACH.

THE PEACH-TREE BORER.

(*Sannina exitiosa.*)

This is the most destructive insect enemy with which the peach grower has to contend.

The adult is a pretty day-flying moth, of a glossy steel-blue color.

The eggs are laid during summer upon the bark of the trunk, near the ground, or just below the surface, and the young larvæ burrow through to the inner bark and sap-wood of the roots, undergoing complete transformations within the year. The larva is a soft, dull-whitish caterpillar, with a reddish-brown head, resembling in general appearance the Round-headed Apple-tree Borer, from which it is readily distinguished by having six scaly and ten fleshy legs. When full-grown it spins a

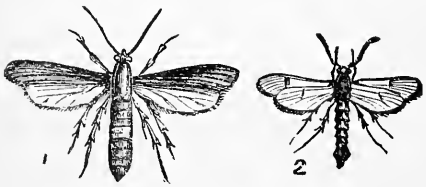


FIG. 68.—PEACH-TREE BORER.
1. Female. 2. Male. (*Riley.*)

follicle of silk near the surface and enters upon the pupal stage, which lasts for from three to four weeks, and then emerges as the moth.

Remedies.—The best remedy is the use of the knife. After harvesting the crop the trees should be gone over, and wherever there is found an exudation of gum at the base of the trunk the borer is surely present.

The diseased bark should be cut away and a flexible probe thrust into each cavity to kill the borer within. The trees should then be painted with a wash made of whale-oil soap, to which a little crude carbolic acid has been added.

Sometimes scalding water is used to kill the borer, after scraping away the gummy exudation about the base of the tree; or, the base of the trunk may be protected by fastening a covering of straw or paper around the tree. Paris green, at the rate of one pound to fifty gallons of water, to which glucose or molasses is added, to give the trunks a substantial coat of adhesive poison, is also resorted to as a means of destroying the young borers while tunneling into the bark.

THE BLACK-PEACH APHIS.

(*Aphis persicæ-niger.*)

There are two forms of this insect—one winged and the other wingless—infesting the roots, leaves, and twigs of the peach.

Both are shining black in color. They multiply with the characteristic rapidity of other aphides previously described.

Remedies.—Spray with kerosene emulsion for the forms infesting the limbs, leaves, and twigs; for those attacking the roots, tobacco dust or tobacco stems should be dug in about the roots. Kainit is also said to be efficient for this purpose.

THE PEACH APHIS.

(*Myzus persicæ.*)

This insect is frequently confounded with the Black-peach aphis which it resembles in appearance, and somewhat in habits and life history.

It has a much wider geographical distribution, being abundant in all the peach-growing regions of the United States. The peach aphis is a soft blackish insect, viviparous in summer. The spring brood is produced from minute black eggs laid in the previous autumn.

Remedy.—Spray with kerosene emulsion.

OTHER INSECTS INJURIOUS TO THE PEACH.

The Plum curculio, Flat-headed Apple and Cherry Borers, the New York weevil and the Peach-tree Bark-louse are all more or less destructive to the peach.

The plum curculio is more difficult to manage on the peach, for the foliage is very easily injured by the use of mineral poisons. London purple should never be used on peach trees, and spraying with Paris green, if done at all, requires caution; the poison must be of good quality, finely powdered, and applied with a nozzle that throws a fine, mist-like spray.

The proportion of Paris green to water should be one pound of the poison to from 300 to 400 gallons of water.

GENERAL TREATMENT OF THE PEACH.

Spraying must be done very early in the season, and the machine should be provided with a nozzle throwing a very fine spray. Finely powdered Paris green of the best quality should be used.

As a protection against the borer, wash the base of the trees with the cement wash prescribed on page 50.

Where trees appear to be infested by the Root Aphis, dig in refuse tobacco about the roots.

PART III.

INSECTS INJURIOUS TO SMALL FRUITS.

THE STRAWBERRY.

THE STRAWBERRY CROWN-BORER.

(*Tyloderma fragariæ.*)

In the adult state this insect is a small, chestnut-brown snout-beetle, belonging to the same family as the Plum curculio. When not fully matured, the strawberry crown-borer is often of a nearly uniform yellowish-brown color, with imperfectly defined black spots on each side of the back. The eggs are deposited on the plants, and a single brood develops each year. The grubs tunnel into the crowns, destroying the embryo fruit, as well as the leaves and stalks of the plant. The larvæ are about one-fifth of an inch long, stout and without legs, pure white in color, with pale, horny, yellow heads.

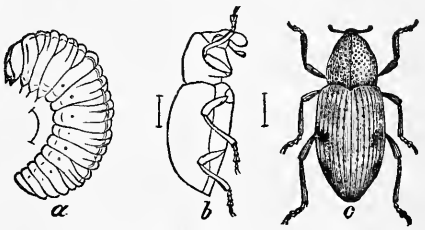


FIG. 69.—STRAWBERRY CROWN-BORER.
a. Grub. *b* and *c*. Beetle.

Remedies.—The pest is most common on old standing beds; the beetles are unable to fly, and the grubs being without legs, this species does not migrate far from infested plantations.

Says Prof. Garman (Kentucky Experiment Station, Bulletin No. 31): "There is little danger of the borer getting among plants on new land at a distance from infested beds as long as the plants for new beds have not been obtained from infested ones.

"Grubs and pupæ spend all their lives in the crown of plants, being found there from the middle of June until late in September. Plants removed from infested beds during this time are, therefore, liable to

convey the borers to localities to which such plants may be transferred. Those who have had experience with the borers have found that care with regard to selecting plants and ground for new beds was their best means for avoiding injury. No fear need be entertained of the borers attacking seriously other crops which may be grown on infested land, and there is every probability that one season in corn or potatoes would rid land of them."

Spraying the plants with Paris green or hellebore water, as directed for the strawberry leaf-beetle, is said to be an effectual remedy for the crown-borer; but as these insects feed upon the interior substance of the plants, and are rarely discovered until the plants are already ruined, the best method is to dig up and burn all infested plants.

THE STRAWBERRY CROWN-MINER.

(*Anarsia lineatella.*)

The larva of a small dark gray moth whose eggs are deposited on the crown of the plant. The worm is a small reddish caterpillar that tunnels through the crown in all directions.

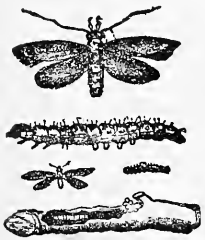


FIG. 70.—THE STRAWBERRY CROWN-MINER. (*Glover.*)

Remedies.—No effective artificial remedy is known. Burning over the fields in autumn affords some protection, but when fields are badly infested they should be plowed in fall or spring and planted to other crops.

In small garden plots drenching the plants and saturating the soil about their roots with pyrethro-kerosene emulsion may destroy many of the small caterpillars. Dilute the emulsion with from 25 to 35 parts of water. The surest way of exterminating the pest, however, is to pull up and burn all infested plants.

THE SMEARED DAGGER.

(*Apatela oblinita.*)

The adult is a gray moth with a wing expanse of from one and three-quarters to two inches. The fore wings and front of the body are ashen gray, obscurely marked with black, and the hind wings are nearly white. The larva is a brilliant-colored caterpillar, about one and a half inches long when full-grown. The head is brown or black and the body brown, ornamented with longitudinal bands of bright

yellow. Brown, yellow and black spines rise from tubercles along the back; in some specimens the divisions of the body are marked with cross-bands of brilliant crimson.

In the central states two broods appear yearly, one in June and the other about September. When full-grown the caterpillar seeks a sheltered spot in rubbish or fence corners, and spins a gray silken cocoon in which the winter is passed in the pupa state.

This insect also attacks the apple, peach, grape, raspberry, and several ornamental shade trees; also corn, cotton, and asparagus.

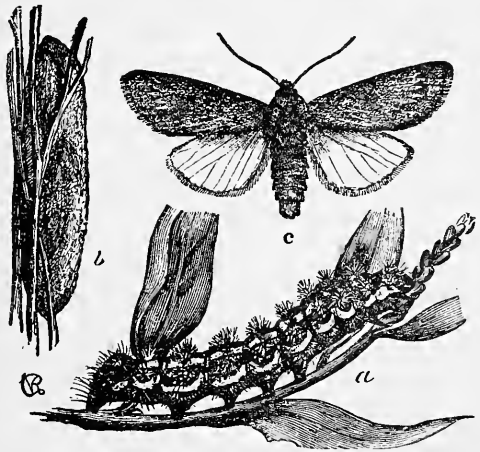


FIG. 71.—THE SMEARED DAGGER.
a. Caterpillar. *b*. Cocoon. *c*. Moth. All natural size.

Remedies.—Spraying with Paris green, one teaspoonful of the poison to two gallons of water, or one ounce of white hellebore to a pailful of water, may be used for destroying the fall brood. For the spring brood, which appears during the fruiting season, pyrethrum powder should be used. The caterpillars are subject to the attacks of several species of parasitic insects.

THE TARNISHED PLANT-BUG.

(*Lygus pratensis.*)

A small brown or yellowish-green bug from one-fourth to one-fifth of an inch long. It varies from yellowish brown with obscure markings to almost black, and has a brownish yellow spot toward the tip of

each front wing. This insect is an active feeder, infesting many plants, and is particularly destructive to the strawberry. It punctures the immature berries, abstracting the sap and causing the malformation known as "*buttoning*," by which the growth is checked, and the fruit caused to shrivel up and turn black. The adult passes the winter hidden under rubbish, mulching and fallen leaves, and with the first mild days of spring is abroad laying its eggs upon such food plants as are sending forth buds. The young soon appear and are voracious feeders, absorbing the sap through their slender beaks and blackening the surrounding parts of twigs and shrubs wherever punctured. There is no dormant pupal period, but from hatching, the bugs are active and voracious feeders. There are two, and probably more broods each season.

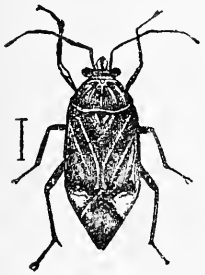


FIG. 72.—TARNISHED PLANT-BUG. Adult, magnified.

Remedies.—Pyrethrum powder, applied with a powder bellows, is the best remedy for this pest.

Kerosene emulsion may also be used after the fruiting season.

The arsenites cannot be used to destroy this pest, since it does not take solid food, but abstracts the sap by inserting its slender beak into the tissues of the food-plant.

Professor H. Garman (Kentucky Experiment Station, Bulletin No. 31, December, 1890), says of this insect:—

"It appears to have few natural enemies. Damp weather has, as in the case of the chinch bug, a good effect in reducing its numbers; an effect, in this case, probably due in part to a new parasitic fungus (an Empusa), which I have observed attacking it in Kentucky."

THE STRAWBERRY LEAF-ROLLER.

(*Phoxopteris comptana.*)

This is the most destructive insect enemy of the strawberry. In the adult form the Leaf-roller is a small, brownish moth, with a wing expanse of about one-half inch. In the Northern United States two broods are known to occur each season, and three, or possibly four, broods occur in the South. Entomologists believe the Leaf-roller to be a Northern insect, which has gradually migrated southward. The depredations of this pest are all confined to the larval or caterpillar

stage of life. The worm feeds almost altogether on the strawberry, but occasionally attacks the raspberry and blackberry.

The larva is a light greenish worm, not quite half an inch long. Soon after hatching, the worm begins to fold the leaves together by drawing the outer edges of the leaflet together, as seen in Fig. 74, and fastening the edges with silken threads. In the retreat thus made the entire larval existence is passed, feeding upon the pulpy parts of the leaf, and causing it to shrivel up and

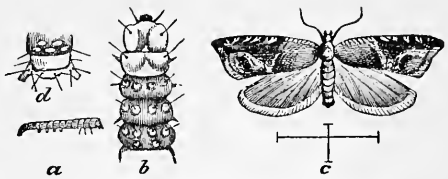


FIG. 73.—THE STRAWBERRY LEAF-ROLLER.

a. Larva, natural size. *b*. Head end of larva, enlarged. *d*. Hind end of larva, enlarged. *c*. Moth, enlarged, the hair lines showing natural size. (*Riley.*)

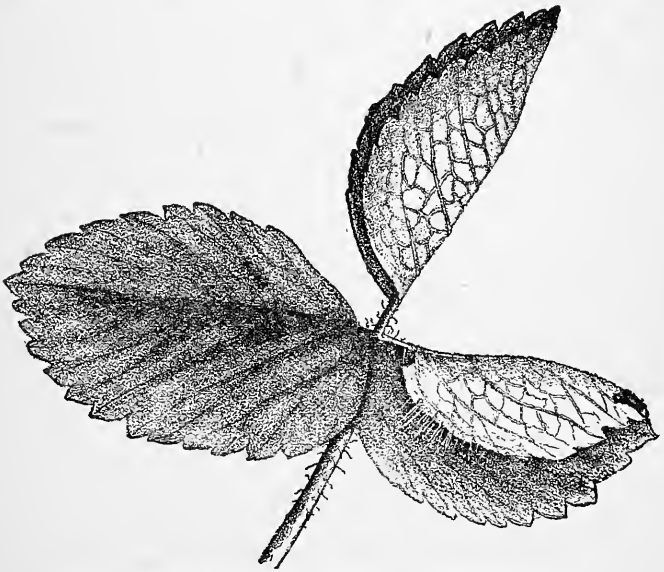


FIG. 74.—STRAWBERRY LEAF FOLDED BY LEAF-ROLLER. (*Garman.*)

turn brown. Here the larva changes to pupa, and finally emerges as the adult moth.

Remedies.—Insecticides, such as Paris green, London purple, and hellebore, have been of little use in checking the ravages of this pest. Securely rolled in the leaflet, the worm is seldom reached by the poison. The pest is, however, effectually exterminated by burning over the beds in October, while the larvæ and pupæ are still in the leaves. The bed should be mown over, and the leaves allowed to dry slightly; a little straw or wood rakings may be scattered over the ground to make sure the killing of the worms. The burning can be done without injury to the vines, and with the certainty that the pest will be destroyed.

THE STRAWBERRY SLUG OR FALSE WORM.

(*Emphytus maculatus.*)

This insect is also known as the strawberry worm. The larva is a slender, yellowish or pale green worm, which riddles the leaves with holes, and at times completely defoliates the plants. The Straw-

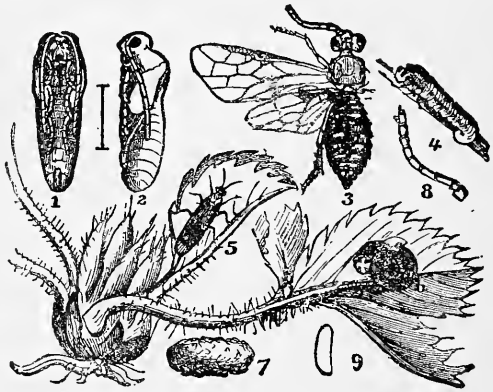


FIG. 75.—THE STRAWBERRY FALSE-WORM.

1, 2. Different views of pupæ which have been removed from the cocoon, enlarged. 3. Winged adult, enlarged. 4. Larva, natural size. 5. Adult, natural size. 6. Larva, as seen coiled up on a leaf. 7. The cocoon in which the larva becomes a pupa. 8. An antenna of the adult fly. 9. Outline of an egg, enlarged.

berry false-worm is the larva of a small, black fly belonging to the same order as the common honey-bee, and is nearly related to the pear and rose slugs.

The full-grown fly is about one-fourth of an inch long, with four

smoky black wings, which are held close to the back when the insect is at rest. The larva, when full grown, is readily recognized from its habit of resting on the under side of the leaf in the coiled position of Fig. 75, 9.

Remedies.—Persian insect powder (pyrethrum) dusted over the leaves by the aid of a powder bellows, may be used when the plants contain fruit. For the second brood, which appears in the larval stage during August, spray with Paris green and water as directed for the strawberry leaf-beetle. (See page 96.)

Dusting the plants with lime just after a rain, or when the leaves are wet with dew, is said to be a good method for destroying the false-worm.

THE STRAWBERRY WEEVIL.

(*Anthonomus musculus.*)

This pest is a small, black beetle, the life history of which is yet very imperfectly known. It attacks the strawberry as soon as the buds begin to appear. Fig. 76 is a greatly enlarged illustration of the adult, taken from Prof. Riley's report for 1885. The strawberry weevil confines its ravages almost exclusively to the buds and blossoms of the perfect flowering varieties, commencing its depredations before the blossom-buds are out. The stamens of infested blossoms are destroyed, and the ovary or center in which the larvæ burrow turns black, whereby the infested blossoms are readily distinguished.

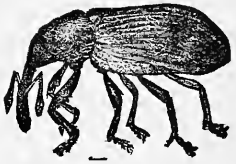


FIG. 76.—STRAWBERRY WEEVIL.
Adult, enlarged. (*Riley.*)

Remedies.—Until the life history of this insect has been more fully studied, no very trustworthy directions can be given for its destruction. Insecticides containing arsenites or anything poisonous to the consumers of fruit should be carefully avoided during the fruiting season.

Prof. M. H. Beckworth, of the Delaware Agricultural Experiment Station, has suggested the use of kerosene emulsion diluted with from nine to fifteen parts of water. Also the use of white hellebore on the plants as used upon currant bushes to destroy the currant worm. The following is the formula suggested by Professor Beckwith (Bulletin 18, Delaware Experiment Station):—

White hellebore	1 ounce.
Common glue	1 "
Water	3 gallons.

Either of these remedies may be sprayed upon the plants as soon as the blossom-buds begin to appear.

STRAWBERRY LEAF-BEETLE.

(*Paria aterrima.*)

A small, brownish-colored beetle, which does great damage to the leaves of the strawberry, at times completely defoliating the plant. The adult insect is about one-eighth of an inch long, with yellowish wing covers, usually marked by two dark or black spots, the anterior one being smaller than the other. The larva of this pest is a small, whitish worm (about one-fourth of an inch long), with a yellowish head. It lives in the soil and feeds upon the roots of the strawberry.

Remedies.—After the fruiting season is over this insect may be destroyed by spraying the plants with Paris green, using one teaspoonful of the poison to two gallons of water.

Dusting the plants with air-slaked lime and powdered hellebore are also said to be effective remedies.

STRAWBERRY ROOT-WORMS.

(*Paria canella, Graphops nebulosus, and Colaspis brunnea.*)

The small, white grubs, which are the larvæ of the above three species of beetles, generally confine their depredations to the fibrous roots of the strawberry. Occasionally they gnaw into the crowns, making irregular channels, which are frequently mistaken for the tunnels of the Crown-Borer. The beetles, which are the mature forms of these root-eating worms, all feed upon the leaves of the strawberry. The first species, *Paria canella*, is a small, black, shining beetle ; the second, *Graphops nebulosus*, resembles the preceding species in shape, and is also of about the same size, but is of a metallic, coppery-brown color ; the third species, *Colaspis brunnea*, is about three-sixteenths of an inch in length and of a uniform, yellowish brown color.

The adults of all three species feed on strawberry leaves, the first species being probably the most destructive to foliage.

Remedies.—The beetles may be readily destroyed after the fruiting season by occasional sprayings with Paris green or London purple.

The subterranean habits of the larvæ render them difficult to deal with. When strawberry fields are badly infested they should be plowed up soon after the fruit is harvested and the land planted to cultivated crops.

WHITE GRUBS.

The white grubs which are so injurious to strawberry plants, especially to those growing on lands which have recently been in grass, are the offspring of several species of brown beetles, known as May or June bugs. The chief injury done by these root-eating larvæ, which are not infrequently confounded with grubs found in farmyard manure, is to grasses, and particularly to lawns. The white grubs spend the greater part of the summer in the earth, feeding on the living roots of grasses and weeds, while the grubs from manure feed exclusively on the dead vegetable matter present in the manure.

White grubs are apt to do much damage the first summer to plantations previously in grass or weeds. As they mature the adult beetles leave the beds and resort to grass lands to deposit their eggs.

When the grubs are at work, the fact is recognizable by the sudden wilting of occasional plants; and if the wilted plants are examined the roots, and perhaps, a considerable part of the crowns are found to be gnawed away.

Remedies.—Dig out all infested plants and destroy the grubs. A dressing of gas-lime at the rate of about two tons per acre has proved an efficient remedy on lands infested with this pest. Broadcast the gas-lime and work well into the soil at least two months before planting to strawberries.

These insects prefer high and well drained lands, and are rarely troublesome on damp, low soils. Fertilizing with farmyard manure is said to afford some protection from the pest.

Autumn plowing and rapid rotation of crops are the best methods for clearing the grubs out of badly infested fields.

A correspondent of the *Rural New Yorker* gives the following scheme for protecting expensive plants from the ravages of the White Grub.

"Having bought four dozen of the Marshall strawberry plants, and paid $10 per dozen, I wanted to set them out on new land (for I find they do best on it); for fear of the worms, I put them in wire-baskets made of old mosquito screen netting. They were about 8 inches long and 6 inches deep, the ends being folded over, and a piece of wire being run through the fold to keep the ends from bursting open. Then they were filled with earth, and the plants put in.

"As the roots can grow through the wire and the worms can eat only what grows through, they cannot kill the plants. I don't know how many of the ends of the roots of the latter have been eaten, neither

do I care, as the parent plants have all lived and done well; but a few of the young ones have been eaten off, but as I kept a good watch of them, I found the worms and killed them. This I recommend only for high-priced plants, and with me it has proved a sure protection." —*Rural New Yorker*, October 21, 1893.

OTHER STRAWBERRY INSECTS.

The strawberry is subject to the depredations of many other insects besides those enumerated in the preceding pages. Only those mentioned are considered of sufficient importance to cause much damage, and the general remedial treatment for others is the same as for these.

For cut-worms and leaf-eating insects Paris green and water, one teaspoonful to two gallons of water, or powdered white hellebore, one ounce to a pailful of water, may be sprayed over the plants after the fruiting season is over. For plant lice, spray with kerosene emulsion.

THE RASPBERRY AND BLACKBERRY.

THE SNOWY-TREE CRICKET.

(*Œcanthus niveus.*)

This little insect, illustrated in Fig. 77, does not confine its depredations to the raspberry and blackberry alone, but often causes much injury to grape vines, at times completely defoliating young vines, and cutting off the fruit as well as the leaves.

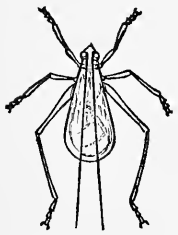


FIG. 77.—MALE OF SNOWY TREE CRICKET. (*Riley.*)

It also infests the peach, maple, willow and some other trees.

The adult is a pale whitish-green, semi-transparent tree-cricket, from three-fifths to seven-tenths of an inch long.

The eggs are deposited in autumn; the female punctures the twigs or canes in an irregular line for an inch or more, and into each cavity thrusts a slender, elongated egg, which is yellowish and semi-transparent. From five to fifteen eggs are thus placed by her long ovipositor in an irregular row, more than half way through the cane. The eggs hatch during early summer into wingless crickets.

These do not feed upon the pith, as might be supposed from the

manner of ovipositing by the adult, but are carnivorous, feeding upon plant lice and other insects during the entire life period.

In this respect the snowy-tree cricket assists the fruit grower in checking the depredations of more injurious species.

Remedies.—It is a mooted question among entomologists whether this insect does more harm than good. However, the undisputed fact remains that raspberry and blackberry fields are sometimes seriously injured by it, and that the injuries are greatest in years following a visitation of aphides. The manner of depositing the eggs and the habits of the insect make it a most difficult pest to fight. The punctured canes are so weakened that they often die, or are broken off by winds.

The irregular row of punctures indicates the presence of eggs, and these are often made more noticeable by partial splitting of the canes. The only known way of fighting this insect is to cut out and burn the canes containing the eggs.

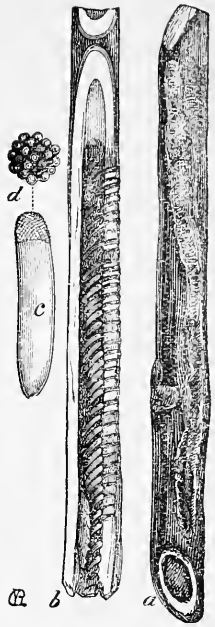


FIG. 78 –EGGS OF SNOWY TREE CRICKET.

a. Egg punctures. *b*. Cane split open to show eggs. *c*. Egg, magnified. *d*. Egg-cap, more magnified. (*Riley*.)

THE CECROPIA EMPEROR MOTH.

(*Attacus cecropia*.)

The large size and handsome coloration of the adult makes the Cecropia Emperor Moth (see frontispiece) one of our most beautiful and interesting insects. In "Insects and Insecticides," pages 131 and 132, Professor Clarence M. Weed thus describes the moth :—

"This moth often measures six or seven inches across the front wings, the ground color of all the wings being a grizzled, dusky brown, with the hind margins clay colored ; near the middle of each wing

there is an opaque, kidney-shaped, dull-red spot, having a white center and a narrow, black edging, and beyond the spot there is a wavy, reddish band bordered internally with white. The fore-wings, next to the shoulders, are dull red with a curved, white band, and near the tips of the same is an

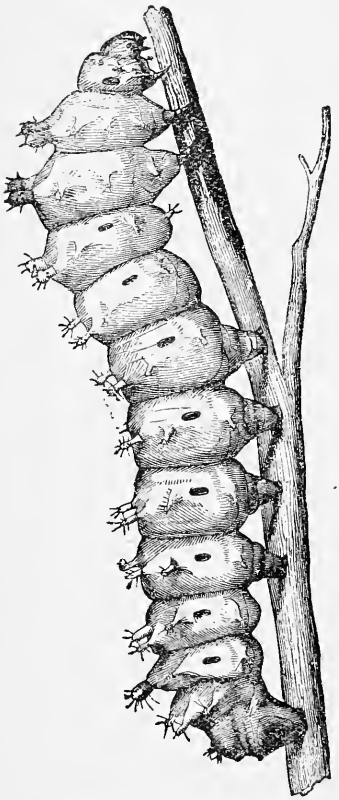


Fig. 79.—Cecropia Emperor Caterpillar.

Fig. 80.—Cocoon of Cecropia Emperor.

eye-like black spot within a bluish-white crescent. The upper sides of the body and the legs are reddish ; the fore part of the thorax and

the hinder edges of the rings of the abdomen are white; the under surface of the body is checkered with red and white."

The moths emerge in May or June, and the eggs for another brood are deposited on the limbs of apple, pear, and a variety of fruit and shade trees, and quite frequently on the canes of the raspberry and blackberry.

The eggs hatch in about a week into small, spine-covered caterpillars, which are voracious feeders, growing rapidly and reaching maturity late in summer. Early in autumn they spin large, grayish, silken cocoons, which are attached to the limbs of trees or shrubs, and change to pupæ.

Remedies.—This insect seldom appears in large numbers. The caterpillars are destroyed by birds, and are subject to the attacks of several parasitic insects.

Hand-picking the caterpillars or cocoons, which are readily seen, is generally practicable; or, in rare cases, the use of the arsenites in suspension with water may be resorted to.

THE RASPBERRY SAW-FLY, OR SLUG.

(*Selandria rubi.*)

The Raspberry Saw-fly, or Raspberry Slug, in the adult stage is a four-winged, black saw-fly, which makes its appearance among the canes in May. The eggs are deposited beneath the skin of the leaf, close to the ribs and veins, producing a slight swelling and discoloration of the skin on the upper surface of the leaf.

The larva is nearly white, semi-transparent, and thickly covered with transverse rows of whitish spines.

Its food is the tender tissues of the leaves. When full-grown the slug is a little over a half inch long; the body is dark green, and thickly covered with green tubercles.

About the middle of June the slugs retire to the earth and construct, just below the surface, oval, earthy cocoons, in which the pupal stage is passed.

The fly emerges the following spring.

Remedies.—The larvæ are readily destroyed by dusting infested canes with white hellebore, or by spraying with a decoction made of from two to four ounces of this drug in from twelve to fifteen gallons of water.

THE RASPBERRY CANE-BORER.

(*Oberea bimaculata.*)

The larva is a footless grub, in appearance much like the Round-headed Apple-tree Borer, and the adult a slender, black beetle with

yellow thorax and a yellow band behind the head. In depositing their eggs, which are laid in the green canes of the raspberry and blackberry, the female beetles make two rows of punctures, about a half an inch apart, double-girdling the canes and causing them to wither. Midway between the encircling band of punctures the eggs are deposited.

The larvæ are cyliudrical, yellowish grubs, measuring in length about three-fifths of an inch. They burrow downward through the pith, penetrating the woody parts of the cane.

FIG. 81.—RASPBERRY CANE-BORER. NATURAL SIZE.

The tunnels are rapidly extended downward, and by autumn the grubs have generally reached the roots of the canes.

The insects remain in the roots until the following summer, when they emerge as adult beetles.

Remedies.—As soon as the tops of the punctured canes begin to wilt they should be cut off below the girdling point and destroyed.

If the infested canes have not been noticed until the entire canes are dead or dying from the operations of the borers within, such canes should be cut out altogether and burned.

Prompt attention before the approach of autumn will prevent the borer from reaching the roots, and save much labor in rooting out infested canes.

THE RASPBERRY ROOT-BORER.

(*Aegeria rubi.*)

The adult is a transparent-winged moth, wasp-like in appearance, and with a black body banded with yellow.

FIG. 82.—RASPBERRY ROOT-BORER. *a.* Male. *b.* Female. (*Riley.*)

The larva is a pale-yellow or whitish caterpillar, with dark-brown head and sixteen legs. The eggs are laid in the morning, on the under side of the leaves, or on the canes, a few inches above or below the soil.

The larva tunnels into the cane, feeding upon the pith and working,

downward toward the root, in which it spends the winter ; in spring it burrows up again, usually in another stalk. Pupation takes place within the cell of the larva, which gnaws nearly through the cane, leaving the cell-walls so thin that the emerging moth easily works its way out.

Remedies.—Cutting out infested stalks, or pulling up and burning the withering canes, when the larvæ have reached the root, is the only effectual remedy known.

THE SQUARE SPITTLE-BUG.

(*Aphrophora quadrangularis.*)

This insect attacks the twigs of the blackberry and is common on weeds and grasses. There are several species of these peculiar insects, and among their food plants, we may mention the grape vine, cranberry and blueberry, and the leaves and twigs of the alder and pine. Professor Fernald, in Bulletin No. 12, Hatch Experiment Station says:—

"The frothy spittle-like masses—called frog spittle, toad-spittle, snake spittle, etc.—are formed by small insects belonging to the family Hemiptera or true bugs, and are seen adhering to the twigs and branches of shrubs and trees, and also to the stems of grasses and other plants.

"During the early stages of its life, by means of special glands, this insect secretes an albuminous liquid and discharges it from the posterior end of the body forcing bubbles of air into it after it has been used in respiration, probably.

"Two different species of spittle insects are common on grass in Massachusetts, *Philœnus spumaris* (Linn.) and *Philœnus lineatus* (Linn.), and they also occur in Europe, from which country they were probably introduced. Although these two insects feed on many different species of plants, it is said that they are strictly attached to grasses and low plants, and that they never occur on trees and shrubs, except by accident.

"It is not known where they lay their eggs, but as the females are provided with saw-like appendages connected with the ovipositor, it is probable that they cut slits in the stems of the plants, near the ground, in which to deposit their eggs. I incline to the impression that they hibernate during the winter in the perfect state, and lay their eggs in early summer. This is true of the allied *Proconia costalis*, and *Heliochara communis*, which I have often found fully developed in early spring, just emerging from their winter quarters. The eggs are very large as compared with the size of the insect, and as but very few are laid, these pests are never liable to become excessively abundant. This insect remains in the frothy secretion during the early stages (nymph), but after reaching the adult stage, does not make this secre-

tion, and becomes very active. Although the wings are well developed it does not fly any great distance, but makes long leaps, and runs quickly, often with a peculiar sideways motion, to the opposite side of the plant from the observer.

"The Lined Spittle-insect (*Philœnus lineatus* Linn.), is about one-fourth of an inch long, of an ocher-yellow color, with a whitish stripe on the costa or outer edge of the wing covers, and a brownish stripe within and parallel to it. Some of the varieties are dark brown with a whitish costal stripe.

"Although the mass of froth on the stems of grass is quite large it usually contains but a single insect, which is so small that it can injure the plant but very little, and it is very seldom that the pest is abundant enough to make any material difference in the hay crop

THE CURRANT AND GOOSEBERRY.

THE IMPORTED CURRANT WORM.

(*Nematus ventricosus.*)

This is a foreign species believed to have been introduced into the United States by nurserymen about 1857. It is a common pest of the garden, often completely defoliating currant and gooseberry bushes about the time the fruit is half developed.

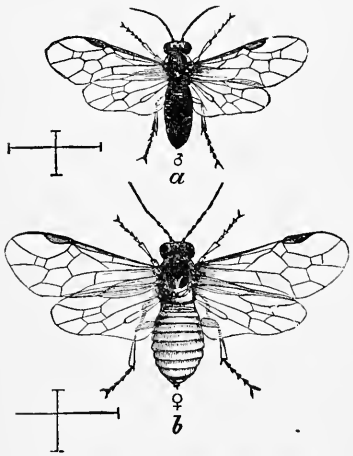


FIG. 83.—THE ADULT OF THE CURRANT WORM.

a. Male. *b*. Female. Lines at the left show the natural size. (*Riley.*)

The worm, when full-grown, is about three-fourths of an inch long, green in color, with numerous black spots. The full-grown worms enter the earth, remaining near the surface or hiding under leaves and litter, where they spin a brown, silken cocoon, in which the pupal stage is passed. The perfect insect is a small, four-winged saw-fly. The male is black with yellow spots, and the female is mostly yellow.

In spring the flies leave the earth and deposit their eggs upon the under-sides of the leaves.

The eggs hatch in about ten days, and the worms begin at once to devour the leaves.

Remedies.—Powdered white hellebore promptly applied to the leaves quickly exterminates the pest.

This insecticide kills both by contact and as a poison. It may be dusted over the leaves with a powder bellows, or be mixed with water in the proportions of two tablespoonfuls of the drug to one pailful of water. Sprinkle over the bushes with a watering-pot, or spray with a force pump and nozzle. More than one application of the insecticide is often necessary.

FIG. 84.

a. Imported currant worms. *b*. Black spots upon a magnified joint of the body. (*Riley.*)

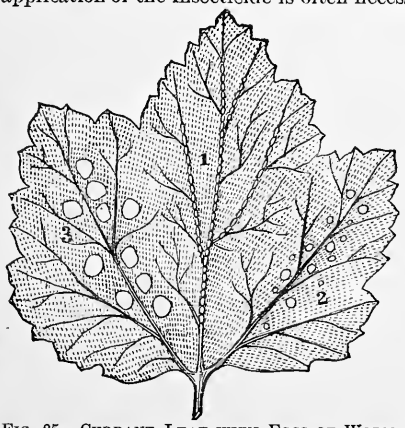


FIG. 85.—CURRANT LEAF WITH EGGS OF WORM. (*Riley.*)

THE NATIVE CURRANT WORM.

(*Pristiphora grossulariæ.*)

Like the imported species, the native Currant worm is the larvæ of a saw-fly. The larva is smaller, however, and does not pupate in the ground, but spins its cocoon among the twigs and leaves of currant bushes.

It is about half an inch long, and of a uniform pale green color.

Two broods occur yearly. The eggs of the second brood are laid upon the twigs, where they remain during the winter.

Remedies.—Treatment should be the same as that recommended for the imported species. (Page 104.)

THE IMPORTED CURRANT STALK-BORER.

(*Aegeria tipuliformis.*)

The adult is a clear-winged moth, belonging to the same genus as the Peach-borer.

The moth is bluish-black, the wings transparent except at the borders, which vary in color from brown to brownish-black. The abdomen is marked by three bright-yellow, transverse bands. The wing expanse is about three-fourths of an inch. The moth lays her eggs on or near the buds, and the larva, a small, whitish worm, hatches in a few days. It burrows into the stem and feeds upon the pith. There is but one brood a year, and the insect undergoes all its transformations in the burrow of the larva, which, as it approaches the time for pupation, gnaws nearly through the stem, leaving a thin layer of bark, through which the emerging moth readily works its way.

The inferior size of the fruit and impoverished growth of the stalk is a sure indication of the presence of this pest. Though commonly infesting the currant this insect is but rarely found on the gooseberry.

Remedies.—Prune in autumn and burn all infested stems.

THE CURRANT LEAF-HOPPER.

(*Empoa albopicta.*)

There are two broods of this insect each year, but the first does the greatest damage to the currant and gooseberry.

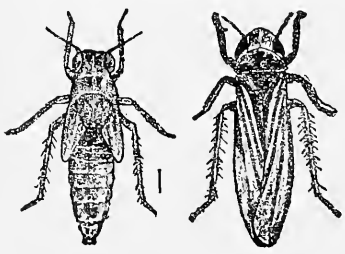


FIG. 86.—CURRANT LEAF-HOPPER.
a. Adult. *b*. Nymph, magnified. (*Weed.*)

This insect is of a pale, greenish color, and is about the tenth of an inch in length. It is found on the under-side of the leaves, late in spring or early in summer, sucking out their substance, and causing tiny white spots on the upper surface of the leaves.

Remedies.—Tobacco powder dusted over the leaves is said to be an effective remedy. Pyre-

thrum, either in powder or decoction, is probably the most desirable insecticide for use in destroying this pest.

THE CURRANT APHIS.

(*Myzus ribis.*)

When the leaves of the currant appear curled, and have a distinct reddish tinge in early summer, the bushes are infested by a small, yellowish louse, which may be found by examining the under-side of the leaves. This species, in habits and life history, is a migratory aphis, much like the aphides previously discussed.

It leaves the currant bushes in mid-summer for some more succulent plants, returning in autumn to deposit its tiny black eggs, which are laid on the stems and buds.

Remedies.—Spray with kerosene emulsion early in the season, before the aphides have appeared in large numbers. For the few bushes of the kitchen garden the curled leaves should be picked off and burned.

THE FOUR-LINED LEAF-BUG.

(*Pœcilocapsus lineatus.*)

Also known as the Black-lined Plant-bug, the Yellow-lined Currant-bug and the Four-striped Plant-bug. This pest is a native of North America, and has a wide geographical distribution extending from about the thirty-second parallel to Canada, and westward to the Rocky Mountains. It has an exceedingly wide range of food-plants. Mr. M. V. Slingerland, in a very full report on this insect, published in Bulletin 58, Cornell Experiment Station, enumerates fifty four species of plants upon which the pest is known to feed. He says: "Fourteen of the plants are useful for food

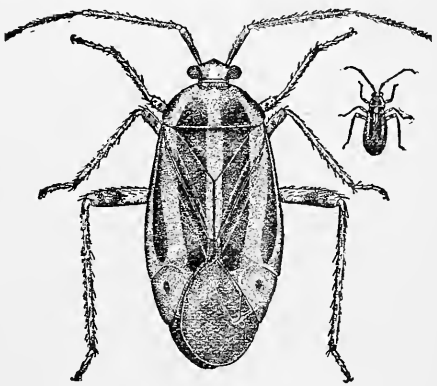


FIG. 87.—THE ADULT INSECT.
Its natural size represented in small figure at the right. (*Slingerland.*)

or medicine, twenty-nine are ornamental, while but eleven are wild species."

Among plants used for food or medicine are the currant and gooseberry, cucumber, squash, radish, lettuce, parsnip, potato, pea, sage, mint, tansy and valeriana officinalis.

The insects make their appearance in the Northern States from the first to the middle of May, and their presence is soon indicated by the small semi-transparent brownish or blackish spots on the tenderest terminal leaves of the currant and gooseberry. When the pest is numerous the growth of the shoots is checked, and the topmost leaves

FIG. 88.—CURRANT LEAVES KILLED BY THE INSECT. (*Slingerland.*)

turn brown and soon die. Mr. Slingerland, in an able discussion of the habits and life history of this insect, says: "As the insect usually confines its attacks to the leaves of the new growth, the fruiting portions of the bushes are injured but little for that season. But the check given to the new growth must materially affect the future bearing-capacity of the whole bush, and especially of these newer portions." * * * * * On the currant, gooseberry, and many other plants, the insect confines its attacks to the leaves, but on some ornamental plants, as the dahlia and rose, the most frequent point of attack seems to be the buds.

The Nymphal Stage.—The young nymphs, when first hatched, are about the twentieth of an inch in length.

"They are easily recognized, however, on account of the shining vermilion red color of the body, marked with large blackish spots on the thorax. The antennæ and legs are of a greenish-black color. The nymphs grow quite rapidly, casting off their skin five times and undergoing considerable changes in markings, as shown in the figure. The body retains the same vermilion red color until the last nymphal stage is reached. The large black spots on the thorax of the newly hatched nymphs are seen to be the beginnings of the wing-pads, which gradually become more and more apparent at each moult. * *

"The full-grown nymph (Fig. 89) is of a bright orange yellow color, and measures about 5.5 mm. (.21 inch) in length. The black wing-pads, which now have a broad yellowish green stripe near the outer margin, are very conspicuous, and extend nearly half way to the end of the abdomen, which is also marked with black. The eyes are prominent and of a dark reddish brown color. The general shape of the nymphs, the relative proportion of the different parts, and the hairs and black markings on the antennæ, legs, and other parts of their bodies, are well represented in the figure. At the fifth or last moult the adult insect appears.

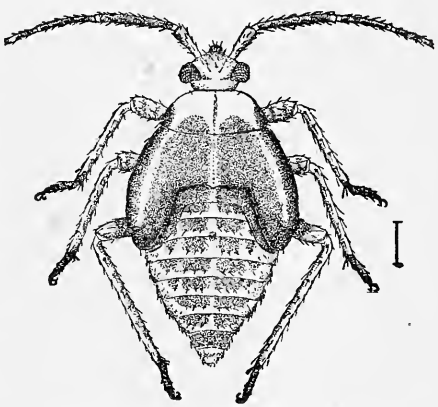


FIG. 89.—NYMPH AFTER FOURTH MOULT. Fifth and last nymphal stage. (*Slingerland.*)

The Adult.—"The general color of the body (Fig. 87) is bright orange yellow; the legs and the portions between the black stripes on the thorax and wing covers are of a dark apple-green color, which usually changes to a lemon-yellow after death. The wing covers are mostly of a leathery texture; the black caudal portion which slopes downward at an angle of about 45 degrees is membranous with the exception of a triangular green portion that usually has a small black

spot near its center. The prominent eyes are of a very dark reddish-brown color." (Bulletin 58, Cornell Experiment Station.)

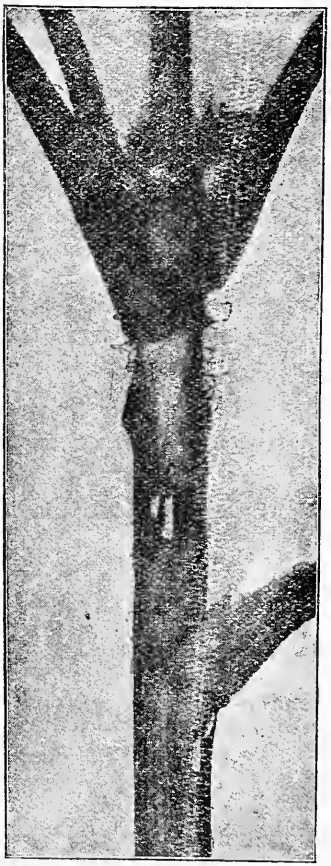


FIG. 90.—CURRANT STEM SHOWING WHITE EGG CLUSTERS, CONSIDERABLY ENLARGED (*Slingerland*).

Remedies.—Kerosene emulsion diluted with five parts of water will probably prove the most effectual remedy for this pest, if applied as soon as the nymphs begin to appear in spring. Mr. Slingerland has discovered that the eggs of the insect are deposited in slits in the stems of shrubs, near the tips of the new growth. He says "all of the eggs are laid before August 1, within four or five inches of the tips of the new growth, and these remain unhatched until the following May.

"On bushes which have been infested this year, these egg scars can soon be found, as the whitish tips of the eggs are quite conspicuous. After a few have been found and their characteristics noted, it will take but a few minutes to look over a bush and clip off the tips of the shoots containing the eggs. Burn these tips (the eggs would doubtless hatch in the spring were they left on the ground) and the pest will be effectually checked. Even if the tips of all the new growth be clipped, the bush would not suffer more seriously than it would from the pest if present in considerable numbers. On small areas, or with choice plants spend a little more time and cut only those tips containing eggs. The eggs remain in these tips nine months, thus making it practicable to do the pruning during the winter months when other work is not so pressing. The

leaves will then also be off and the egg scars can be more easily seen. (Fig. 90.) If currants, gooseberries, or other shrubs have been attacked by this pest, any one can, by examining the tips of this year's growth for the eggs, at once determine whether to expect it next year or not.

"This method of combating the pest is, of course, only applicable to the shrubs, as the eggs will not be found in herbaceous plants. But we believe that this pruning and burning of the tips of the new shoots of currants, gooseberries, and other shrubs attacked by the insect will prove one of the most practicable, and certainly very efficient, methods of preventing the ravages of this Four-lined Leaf-bug.

"The 'jarring' method for destroying the nymphs or adults. On small areas, where choice bushes are attacked, or when the pest appears on ornamental herbaceous plants, the safest, most practicable and efficient way to combat it will be by this method. This can best be done by jarring or knocking the insects into a pan or dish of some kind partially filled with water and kerosene. The bug in all of its stages drops quickly when the bush is jarred.

"Thus, there are three practicable methods by which this pest can be controlled: kerosene emulsion for the nymphs; destruction of the eggs by pruning; and the capture of the nymphs and adults by jarring into receptacles where they are destroyed. Circumstances will largely determine which method will prove the most practicable in specific cases."

THE GOOSEBERRY FRUIT-WORM.

(*Dakruma convolutella.*)

The Gooseberry Fruit-worm is the larva of a pale grayish moth whose eggs are laid upon the young fruit.

The larva bores into the berry and feeds upon the substance of the growing fruit. When full-grown the caterpillar is about three-fourths of an inch long, of a pale greenish color, with a brown, horny-like head. It then lowers itself to the ground by a thread, spins a thin, silken cocoon, hidden among leaves and litter, and passes the winter in the pupa state. But one brood of larvæ appear yearly.

Remedies.—Hand-picking the infested berries. These are conspicuous, being fastened together in clusters of a half a dozen or more, by means of silken threads spun by the worms.

Poultry, if permitted to forage over the ground, will destroy large numbers of the pupæ. Leaves and rubbish about the bushes should be raked up in autumn and burned.

This insect is more common on the gooseberry than on the currant, but occasionally is quite destructive to the fruit of the latter.

THE GOOSEBERRY SPAN-WORM.

(*Enfitchia ribearia.*)

This pest shows a decided preference for the gooseberry, though by no means uncommon on the currant.

It is the larva of a native moth, pale-yellow in color, with faint, dusky, or steel-colored wings. The tiny eggs are deposited on the branches and twigs of the bushes, and usually hatch during May.

The caterpillar, when full-grown, measures about an inch in length, and is of a light-yellow color, with black spots and lateral whitish lines extending the length of the body. The period of pupation is spent in the ground, near the surface, or concealed under fallen leaves and rubbish. The pupal stage is completed in about two weeks.

This insect is at once distinguished from the other pests infesting the gooseberry and currant by being what is commonly known as a measuring worm. When disturbed it lets itself down from leaf or stem by a silken thread, as seen in Fig. 127.

Remedies.—Treat as for the Imported Currant Worm, page 105.

GENERAL TREATMENT.

A number of other insects occasionally attack the currant and gooseberry. General treatment should consist in spraying or dusting with hellebore soon after the opening of the leaves.

Keep a sharp lookout for stems infested by borers, and wherever indicated by the sickly appearance of the foliage, cut off the stems and burn.

THE CRANBERRY.

THE VINE-WORM.

(*Rhopobota vacciniana.*)

This insect, also called the Fire-worm or Blackhead, is the larva of a rather sluggish moth of a dark, ash gray color tinged with brown. Across the fore wings are oblique bands of light brown. The hind wings are of a uniform smoky brown.

FIG. 91.—VINE-WORM MOTH. (*Smith.*)

The moths are sluggish in movement, and do not readily fly when disturbed.

They fly but a short distance when alarmed, and soon settle down upon the vines.

Remedies.—Reflowing the vines after the eggs hatch is the cheapest remedy, but this is thought to injure the keeping qualities of the berries. The experiments of Professor Fernald (Bulletin 19, Hatch Agricultural Experiment Station), indicate that Paris green or London purple, at the rate of one pound of the poison to from 200 to 300 gallons of water, sprayed over the vines is a safe and efficient remedy. About two quarts of glucose or molasses added to each 150 gallons of water causes the poison to adhere more securely to the leaves; nor is it so readily washed off by showers. Professor Fernald's experiments establish the fact that it is not safe to use on cranberry vines more than one pound of the poison to each 100 gallons of water.

THE FRUIT-WORM.

(*Mineola vaccinii.*)

Also the larva of a moth which appears in bogs about the time the fruit begins to set. "They lay their eggs," says Professor Fernald, "at the blossom end of the young berry, often beneath one of the triangular lobes of the calyx. The egg is very much flattened, of a pale, yellow color, and hatches in five or six days after it is laid. For a day or two the worm feeds on the outside of the berry, in the calyx, after which it makes its way into the berry, eats out the seed chamber, and then migrates to another. 'The larva,' according to Professor Smith, 'reaches maturity in September, sometimes not being fully grown at picking-time. It is then rather more than half an inch in length, of a bright-green color, usually with a reddish tinge on the back. The head is narrower than the first segment, and is of a paler, more yellowish color, except the mouth, which is brown. The segments are transversely wrinkled, and are clothed with a few sparse and rather long hairs.'

"When fully grown, the larva leaves the berry and, descending to the ground, spins its cocoon in the sand, within which it changes to the pupa, in which state it remains till the following July, when the moth emerges and lays its eggs on the young berries.

"There seems," continues Professor Fernald, "to be a prejudice among the cranberry growers against the use of Paris green as an insecticide, but when they realize how small an amount is used, and that this is entirely washed off before picking-time, they will see that there is no possible chance for an accident. As evidence that the poison is soon removed, I will state the fact that a cherry-tree was sprayed with Paris green in water, in Cambridge last summer, to

destroy the gypsy moths ; and four days afterward the food was picked and canned. The regulation Paris green scare then occurred, and two jars of the canned cherries were sent here to the Experiment Station, and Dr. Goessmann made an analysis of the contents of each jar; but in neither of them was there found the slightest trace of arsenic or copper, and therefore they contained no Paris green whatever."

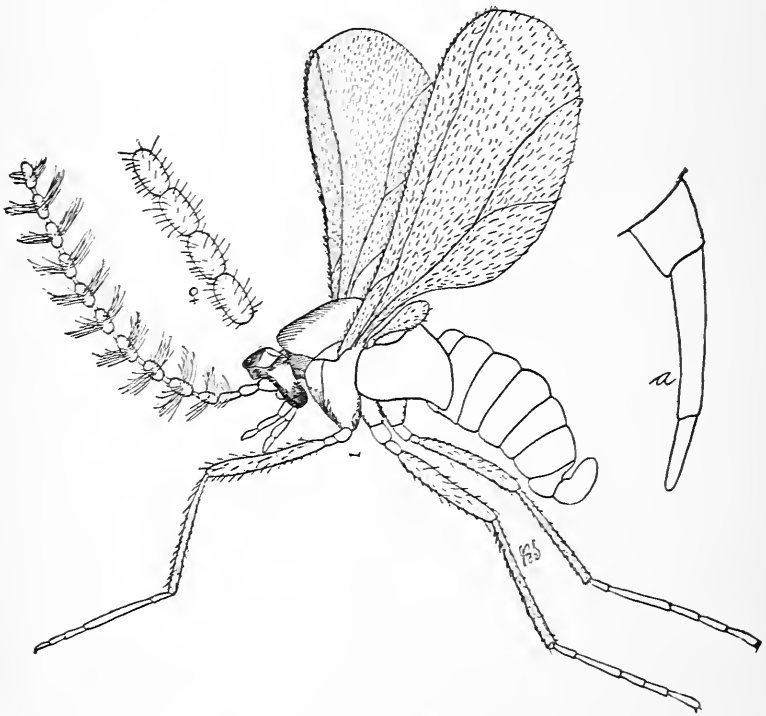


FIG. 92.—THE TIP-WORM (*Male imago*).

Antennal structure of female shown at left. *a*. Ovipositor of female, greatly enlarged. (*Smith.*)

Several other insects are occasionally injurious to the cranberry ; among these are the Bud-worm, which is the larva of a reddish brown beetle ; the Tip-worm (*Cecidomyia vaccinii*, Smith), and the larva of a saw-fly, which deposits its eggs in a slit made in the leaf.

We know of no recorded experiments with remedies for these minor pests. The insecticides used for destroying the Vine-worm and Fruit-worm will probably be found efficient.

THE GRAPE.

THE GRAPE PHYLLOXERA.

(*Phylloxera vastatrix.*)

There are two forms of this insect which have proved so destructive in the grape-growing countries of Europe, one infesting the roots and the other the leaves. We can do no better than to quote the words of the eminent entomologist, Dr. C. V. Riley, to whom the world is

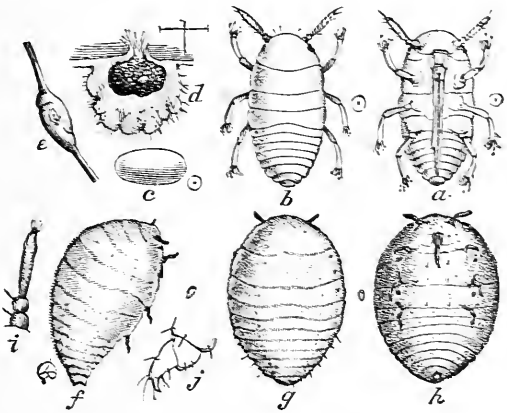


FIG. 93.—GRAPE PHYLLOXERA, LEAF FORM.

a, *b*. Newly hatched nymphs, dorsal and ventral view. *c*. Egg. *d*. Section of gall. *e*. Swelling of tendril. *f*, *g*, *h*. Mother of gall-louse, lateral, dorsal, and ventral views. *i*. Her antenna. *j*. Two-jointed tarsus. Natural sizes indicated by small dots or figures. (*Riley.*)

indebted for a correct knowledge of the habits and life history of this insidious pest.

In the Seventh Report, as State Entomologist of Missouri, Dr. Riley says:

"It hibernates mostly as a young larva, torpidly attached to the roots, and so deepened in color as generally to be of a dull brassy-

brown, and, therefore, with difficulty perceived, as the roots are often of the same color. With the renewal of vine growth in the spring, this larva molts, rapidly increases in size, and soon commences laying eggs. These eggs in due time give birth to young, which soon become virginal, egg-laying mothers, like the first ; and like them, always remain wingless. Five or six generations of these parthenogenetic, egg-bearing, apterous mothers follow each other, when—about the middle of July, in this latitude (Missouri)—some of the individuals begin to acquire wings. These are all females, and, like the wingless mothers, they are parthenogenetic. Having issued from the ground, while in the pupa state, they rise in the air and spread to new vineyards, where they deliver themselves of their issue in the form of eggs or egg-like bodies—usually two or three in number, and not exceeding eight—and then perish. These eggs are of two sizes, the larger about 0.02 inch long, and the smaller about three-fifths of that length. In the course of a fortnight they produce the sexual individuals, the larger ones giving birth to females, the smaller to males. The sexual individuals are born for no other purpose than the reproduction of their kind, and are without the means of flight or of taking food, or excreting.

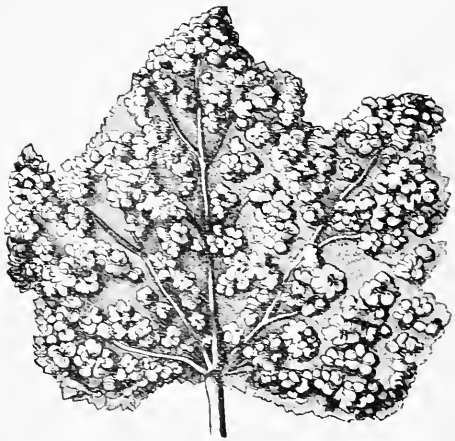


FIG. 94.—PHYLLOXERA GALLS ON GRAPE LEAF. (*Riley.*)

"They are quite active and couple readily, one male being capable of serving several females: the abdomen of the female, after impregnation, enlarges somewhat, and she is soon delivered of a solitary egg, which differs from the egg of the parthenogenetic mother only in becoming somewhat darker.

"This impregnated egg gives birth to a young louse, which becomes a virginal egg-bearing wingless mother, and thus recommences the cycle of the species' evolution. But one of the most important dis-

coveries of Bolbiana, is that, during the latter part of the season, many of the wingless hypogean mothers perform the very same functions as the winged ones ; *i. e.*, they lay a few eggs which are of two sizes, and which produce males and females, organized and constructed precisely as those born of the winged females, and like them producing the solitary impregnated egg. Thus, the interesting fact is established that even the winged form is by no means essential to the perpetuation of the species ; but that if all such winged individuals were destroyed as fast as they issue from the ground, the species could go on multiplying in a vineyard from year to year.

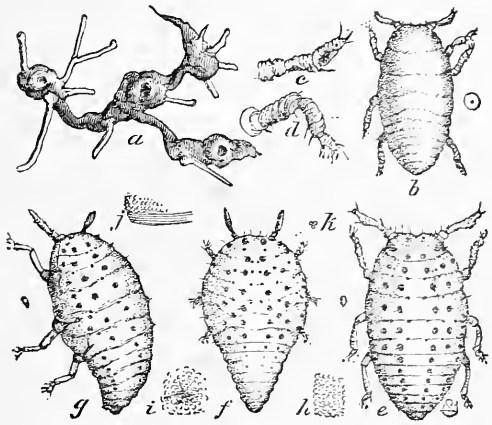


FIG. 95.—GRAPE PHYLLOXERA, ROOT-INHABITING TYPE.

a. Roots of Clinton vine, showing relation of swellings to leaf-galls, and power of resisting decomposition. *b.* Larva as it appears when hibernating. *c, d.* Antenna and leg of same. *e, f, g.* Forms of more mature lice. *h.* Granulations of skin. *i.* Tubercle. (*Riley.*)

"We have, therefore, the spectacle of an underground insect possessing the power of continued existence, even when confined to its subterranean retreats. It spreads in the wingless state from vine to vine, and from vineyard to vineyard, when these are adjacent, either through passages in the ground itself, or over the surface. At the same time it is able in the winged condition, to migrate to more distant points.

"The winged females, as before stated, begin to appear in July, and continue to issue from the ground until vine growth ceases in the fall. Yet they are much more abundant in August than during any other month, and on certain days may be said to literally swarm.

"Every piece of root a few inches long, and having rootlets, taken from an infested vine at this season, will present a goodly proportion of pupæ; and an ordinary quart preserve jar filled with such roots and tightly closed, will furnish daily, for two or three weeks, a dozen or more of the winged females, which gather on the sides of the jar toward the light.

"We may get some idea, from this fact, of the immense numbers that disappear through the air to new fields, from a single acre of infested vines, in the course of the late summer and fall months. If to the above account we add that occasionally, individuals abandon their normal underground habits, and form galls upon the leaves of certain varieties of grape-vine, we have, in a general way, the whole nature of the species."

Remedies.—In Europe the practice is to graft native vines on American stocks, which are phylloxera proof, and by irrigation or submersion to drown out the pest. Sulpho-carbonate of potassium, bisulphide of carbon, and kerosene emulsion are effective remedies.

THE GRAPE-VINE FLEA-BEETLE.

(*Graptodera chalybea.*)

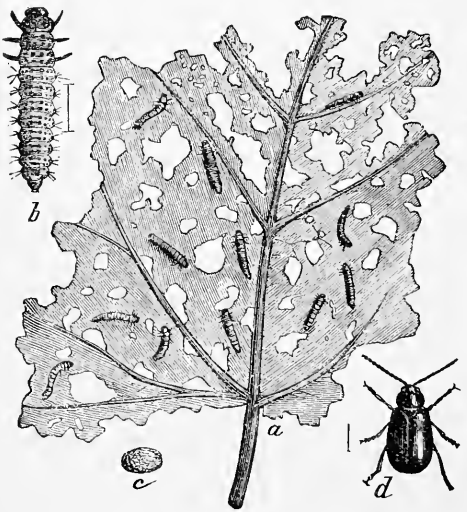


FIG. 96.—GRAPE-VINE FLEA BEETLE.
a. Leaf infested by larvæ. *b*. Larva, magnified. *c*. Cocoon. *d*. Beetle, magnified. (*Riley.*)

This insect, a small, steel-blue beetle, hibernates during winter in the woods or in rubbish accumulations of vineyards.

Its mischievous work begins with the swelling of the vine-buds in spring, and it is at this time, by boring into the buds, that the greatest damage is done.

The beetles continue feeding on the tender leaves and flower buds for about a month, and late in May the

females lay their small, orange-yellow eggs in clusters on the under surface of the leaves. The eggs soon hatch, and the young, dark-colored larvæ begin to riddle the foliage, as seen in Fig. 96. When present in large numbers the grubs completely devour the leaves, leaving a ragged skeleton of ribs. The larvæ are full-grown in about a month. They then measure nearly three-tenths of an inch in length, and are brownish in color, and marked with several black dots on each segment of the body. They now descend to the ground and construct small, earthen cells in the soil, and change to yellowish pupæ. The adult beetles emerge in about three weeks and begin to feed upon the leaves, but do comparatively little injury.

Remedies.—Dusting infested vines with pyrethrum powder, or spraying with Paris green and water, are the best remedies. (Use one ounce of Paris green to twenty gallons of water.)

THE ROSE CHAFER OR ROSE BUG.

(*Macrodactylus subspinosus.*)

It is as the adult beetle that this pernicious insect inflicts such heavy pecuniary loss on the grape grower.

The mature beetle is a hard, brownish insect, not quite half an inch long, covered with a dull yellowish down; the legs are pale reddish and the joints of the feet tipped with black. "They come forth from the ground," says Dr. Harris in his "*Insects Injurious to Vegetation*," "during the second week in June or about the time of the blossoming of the Damask Rose, and remain for from thirty to forty days. At the end of this period the males perish, while the females enter the earth, lay their eggs, return to the surface, and, after lingering a few days, die also."

The eggs, about thirty in number, hatch in from fourteen to twenty days, and the young larvæ feed upon the small roots of grass, etc., within their reach, and attain full growth by autumn. Late in autumn the grubs descend into the earth below the reach of frost and hibernate through the winter.

With the return of spring the grubs come up near the surface and construct oval-shaped cells, in which transformation to pupæ takes place. Three or four weeks later, or about the time the grapes are in blossom, the adult beetles come forth, and at once begin their depredations.

This pest is not confined to the grape and rose alone, but attacks many plants and trees.

The blooms and leaves of apples, plums, pears, peaches, raspberries and blackberries are all devoured by this insect.

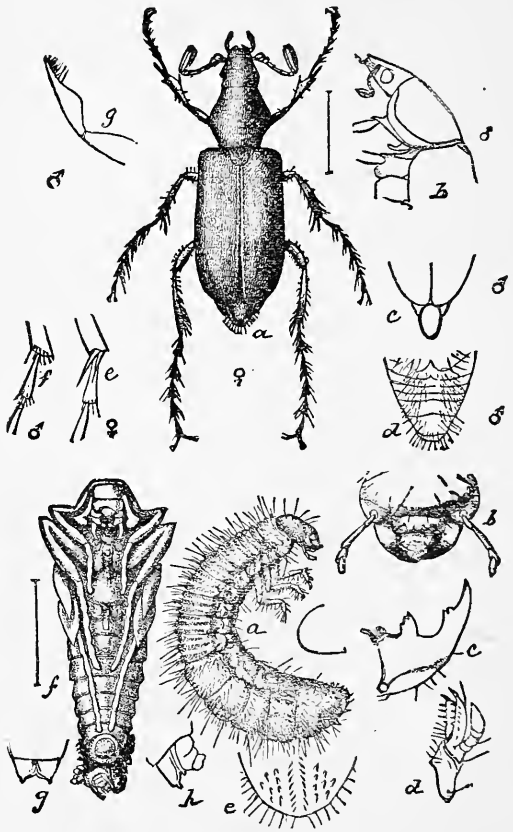


FIG. 97.—ROSE CHAFER.

a, above, Adult female. *a*, below, Larva. *f*. Pupa. All largely magnified. (*Riley.*)

The beetle state lasts for about one month, and there is but one brood each year. This species has a wide geographical distribution

throughout the United States, but is most abundant and destructive on light, sandy soils.

Remedies.—The Rose Chafer is indeed a most difficult insect to fight. Dusting or spraying with pyrethrum powder stupefies the beetles for a time, when they may be jarred from the vines on sheets and destroyed. The author has used kerosene emulsion made with a decoction of pyrethrum powder (see formula, page 47) with considerable success, using one part of the emulsion to ten parts of water. Many beetles succumbed to this treatment, and when the vines were sprayed every other day for a week, the bugs that were not killed left the vines for other plants.

Spraying with a wash made of about three pecks of freshly-slaked lime and a quart of crude carbolic acid, to which fifty gallons of water is added, is said to be an effective remedy.

THE SPOTTED GRAPE-VINE BEETLE.

(*Pelidnota punctata.*)

A large and clumsy beetle that feeds upon the leaves of the grape, but is rarely present in sufficient numbers to be a formidable pest. The general color of the adult is a slightly metallic yellowish-brown on the back, with three distinct black dots on each of the wing covers; the thorax is usually a little darker than the wing covers, and is marked by one distinct black dot on either side. The abdomen and legs are of a brilliant bronzed green color.

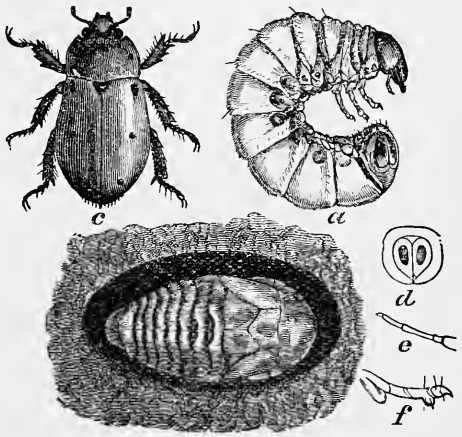


FIG. 98.—SPOTTED GRAPE-VINE BEETLE.
a. Larva. *b.* Pupa. *c.* Beetle. (*Riley.*)

As will be seen from Fig. 98, the larva bears a close resemblance to the common *white grub*, the larva of the May beetle, but is whiter and less wrinkled.

The larva is believed to require three years in which to complete its growth. When full-grown it constructs a rather unsubstantial cocoon in which to pupate. The pupal stage lasts for eight or ten days, when the adult beetle emerges, and is found on the vines during July, August and September.

Remedies.—This insect has never been known to be abundant or to do very material injury to the vine. We know of no remedy but hand-picking.

THE ACHEMON SPHINX.

(*Philampelus achemon.*)

This insect is widely distributed throughout the United States and Canada. The adult is a beautiful hawk-moth, measuring about three and a half inches across the expanded wings. The general color is

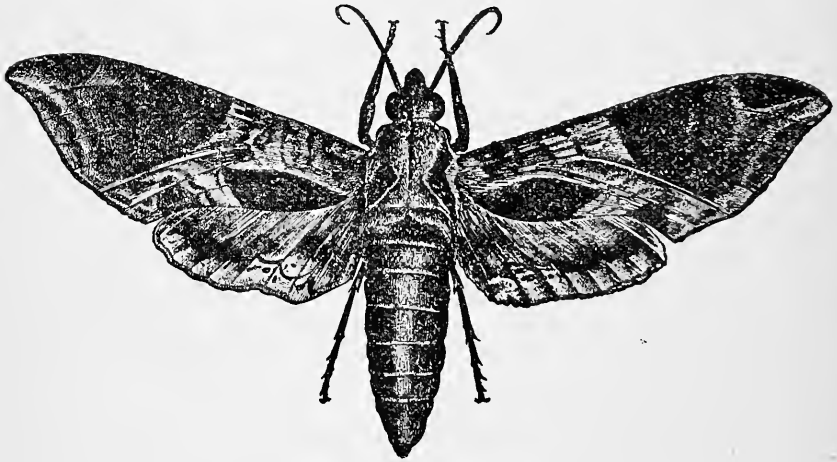


FIG. 99.—SATELLITE SPHINX.

brownish-gray, handsomely variegated with lighter shades of brown, and with deep brown spots on the wings and body.

The hind wings are pink, marked with a reddish shade across the middle and with a row of dark spots in a wide border of gray along the hind margins of the lower wings.

The eggs are deposited on the under side of the leaves of the grape and Virginia creeper, and hatch in a few days into small, green worms. By September the larvæ are full-grown, they are then nearly four inches

long. The full-grown worms are sometimes green like the young ones, but are more generally of a pale yellowish or reddish-brown color, deepening to brownish shades on the sides; numerous minute dots cover the body, and on the sides are six cream-colored spots. When about to transform, the caterpillars are beautiful crimson or pink. They then descend to the ground and form a smooth cavity a few inches under the surface and change to dark mahogany colored chrysalids, emerging as moths the following year.

Remedies. — The large size of the caterpillar renders it a conspicuous object, and the fact that it is never present in great numbers, makes this insect very easily controlled by hand-picking.

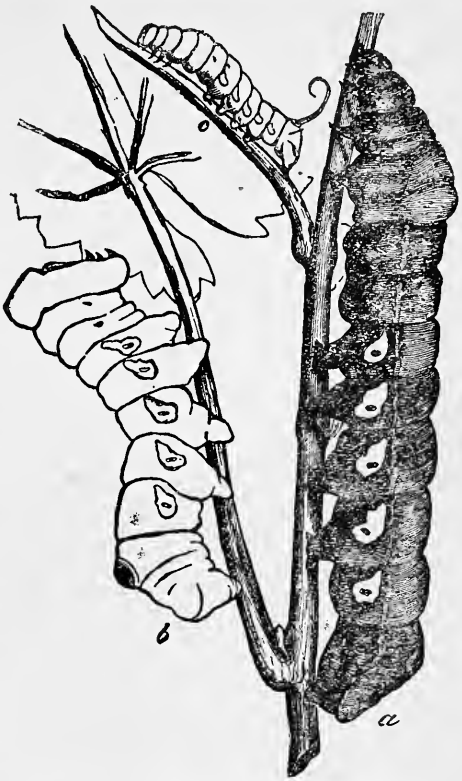


FIG. 100.—CATERPILLAR OF SATELLITE SPHINX.
a. Mature larva. *b.* At rest. *c.* Young larva.

THE SATELLITE OR PANDORUS SPHINX.

(*Philampelus pandorus.*)

This species is closely related to the Achemon Sphinx, to which it bears a strong resemblance in habits and life history. It feeds on the grape and the Virginia creeper. (See Fig. 99, page 122.)

Remedies.—This insect does little damage to the vine, and should be held in check by hand-picking.

THE ABBOT SPHINX.

(*Thyreus abbotii.*)

The larva of this insect is also one of the large grape-feeding caterpillars, but is less common than any of the preceding species. It feeds upon the wild and cultivated grape and the Virginia creeper, but so far as we know has never been seriously injurious to the vine. The adult is a beautiful chocolate-brown or grayish-brown moth, with a wing

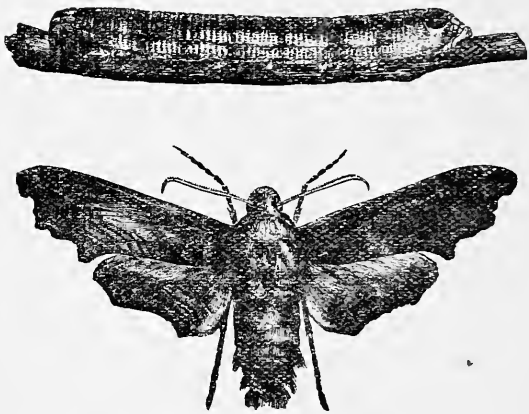


FIG. 101.—ABBOT SPHINX.—Larva and moth. (*Riley.*)

expanse of about two and a half inches. The wings are scolloped and marked as in Fig. 101.

The larva varies considerably in color, from dull yellowish to reddish-brown, and when full-grown is about two and a half inches long.

The larva is full-grown in late summer. It then retires to the ground and forms a superficial cocoon or cell in which to pupate. The moth emerges the following spring, usually in March or April.

Remedies.—This insect does little injury, and is easily held in check by hand-picking.

THE GRAPE-VINE LEAF-HOPPER.

(*Typhlocyba vitis.*)

These little insects are generally, but incorrectly, known as **Thrips.**

The species is thus described by Dr. Harris :—

"In its perfect state it measures one-half of an inch in length. It is of a pale yellow color ; there are two little red lines on the head.

"The back part of the thorax, the scutel, the base of the wing-covers, and a broad band across their middle are scarlet; the tips of the wing-covers are blackish, and there are some little red lines between the broad band and the tips.

"The head is crescent-shaped above, and the eyelets are situated just below the ridge of the front. * * * * They make their appearance on the leaves in June, when they are very small and not provided with wings, being then in the larval state. During most of the time they remain perfectly quiet, with their beaks thrust into the leaves, from which they derive their nourishment by suction. If disturbed, however, they leap from one leaf to another with great agility. As they increase in size they have occasion frequently to change their skins, and great numbers of their empty cast skins, of a white color, will be found throughout the summer adhering to the underside of the leaves and upon the ground beneath the vines. When arrived at maturity, which generally occurs during the month of August, they are still more agile than before, making use of their delicate wings as well as their legs in their motions from place to place. * * *

"The infested leaves at length become yellow, sickly, and prematurely dry, and give to the vine at midsummer the aspect it naturally assumes on the approach of winter. In autumn the Leaf-hoppers desert the vines and retire for shelter during the winter beneath fallen leaves and among the decayed tufts and roots of grass, where they remain until the following spring, when they emerge from their winter quarters, deposit their eggs upon the leaves of the vine, and perish."

Remedies.—Dust the vines early in the season with pyrethrum powder or with tobacco dust.

THE BEAUTIFUL WOOD-NYMPH.

(*Eudryas grata.*)

The adult is a beautiful moth with creamy-white front wings, the outer borders gradated with reddish or rusty brown, and the inner

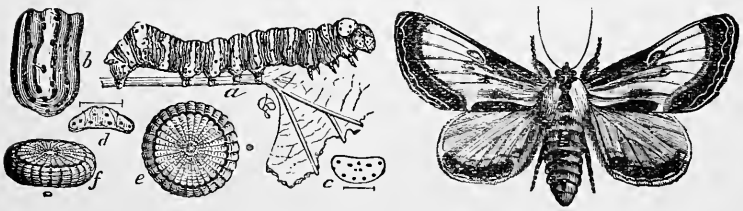


FIG. 102.—BEAUTIFUL WOOD-NYMPH.
a. Larva. *e*, *f*. Egg, magnified. *g*. Moth. (*Riley.*)

ones are glossy olive-green, marked toward the edges with slender, wavy lines of white; the under surface is yellow, marked by a single black spot. The eggs are laid on the under sides of the leaves, and the young larvæ devour the foliage, eating all parts of the leaves, even the midribs. The worms grow rapidly, and by the latter part of summer are fully developed. They are then of a slightly bluish tint, crossed by bands and lines of orange-yellow and black.

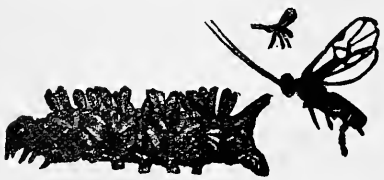


FIG. 103.—GRAPE CATERPILLAR PARASITE.

Pupation takes place during winter in concealment. A few emerge as moths in the fall.

Remedies.—This insect has never been known to be very destructive to the foliage of the vine. It is, to some extent, held in check by parasitic foes. If it appears in numbers sufficient to injure foliage, spraying with decoctions of pyrethrum or white hellebore, or dusting the vines with these insecticides in the form of powder, are effective and easily applied remedies.

THE PYRAMIDAL GRAPE-VINE CATERPILLAR.

(*Pyrophila pyramidoides.*)

The caterpillar is whitish green, deepening in color on the sides. The under surface is pale green. The full-grown caterpillar is about an inch and a half long, with a longitudinal white stripe on the back, broadening on the posterior segments. Low on each side is a bright yellow stripe; between the stripes on the sides and the back is another less distinctly defined stripe on each side of the body. The caterpillar is usually found on grape vines in June. Pupation takes place in the ground about the last of June, the moths emerging in the latter part of July. The moths have a wing expanse of about one and three-fourths inches. The body is dark brown, banded with lighter lines toward the posterior extremity.

FIG. 104.—PYRAMIDAL GRAPE-VINE CATERPILLAR.

Fore wings dark brown with lighter shades of brown and with wavy lines and dots of dull whitish color. Hind wings bright coppery or reddish.

Remedies.—Prof. C. H. Fernald (Hatch Exp. Sta. Bull. No. 12) recommends hand-picking and jarring infested trees or vines.

The caterpillars feed on the apple, plum, raspberry, poplar, etc.

THE GRAPE-BERRY MOTH.

(*Eudemis botrana.*)

The depredations of this insect are not always readily distinguishable from the *Black Rot* of the grape. The adult female is a small, very active bluish moth, that lays her eggs late in June or early in July. The young larvæ are very small, white caterpillars, with cinnamon-brown heads.

When full grown the caterpillars are dark brown or olive-green, tinged with red, and about one-fourth of an inch long. They feed

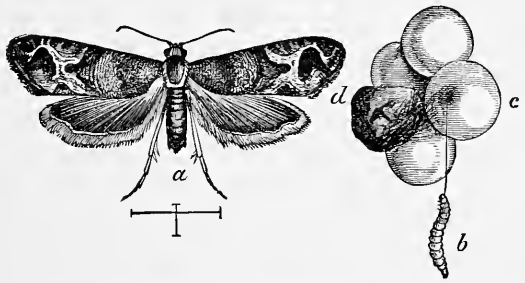


FIG. 105.—THE GRAPE-BERRY MOTH.
a. Moth. *b*. Larva. *c*. Healthy fruit. *d*. Injured fruit. (*Riley*)

upon the substance of the grape, and when one berry has been devoured, the worm fastens an adjoining berry to the ruined one by means of a silken thread, and proceeds to burrow into the sound berry. In this manner several berries are often ruined by a single caterpillar. The caterpillars pupate on the leaf in a cozy little cocoon formed by binding together two crescent-shaped bits cut from the leaf, and bound together in the manner of leaf rolling insects. In about ten days the moths emerge. This species is believed to be two-brooded in the Southern and single-brooded in the Northern States.

Remedies.—Clean culture, gathering and destroying the fallen leaves, and burning infested fruit are the only remedies now known.

THE GRAPE-ROOT BORER.

(*Ægeria polistiformis.*)

This insect rarely does serious injury to the grape. The adult is a small moth, black in color, with bright yellow bars across the abdomen. The larva which does the damage is a dull, whitish caterpillar, measuring, when full grown, from an inch to an inch and three-quarters in length. According to Dr. Riley, the larva then forms "a pod-like cocoon of a gummy sort of silk, covered with little bits of wood, bark, and dirt. As with the peach-borer, this insect requires a year to develop, and is found in its different states of larva, chrysalis, and moth throughout the summer months, and it doubtless also passes the winter as a larva."

Remedies.—When the sickly appearance of the vine indicates the presence of the borer at the root, the soil should be removed and the borer searched for and destroyed. The methods of treatment for this insect are the same as for the peach-borer, to which the grape-root borer bears a striking resemblance.

PART IV.

INSECTS INJURIOUS TO VEGETABLES, GRAINS, AND GRASSES.

ASPARAGUS.

THE ASPARAGUS BEETLE.

(*Crioceris asparagi.*)

This is a European species introduced into the United States about 1860; it soon became very destructive to asparagus in the market-gardening regions adjacent to New York city.

The parent beetle is of a blue-black or shining metallic greenish-black color, with markings of variable shape on the sides of the wing-cases, which are pale yellow; the thorax is brick red, or reddish-brown. Professor Comstock says: "Upon the appearance of the plants in the early spring, and just before the cultivators are ready to begin bunching for the early market, the beetles come forth in great numbers from their hibernating quarters under sticks, stones, rubbish, and especially under the splinters of wood or fences and under the scaly bark of trees, and commence gnawing the tops of the young plants. They pair and lay their eggs very soon. The eggs are oval and are placed endwise on the plant, usually in rows of two to seven. In from seven to ten days the young larvæ begin to make their appearance. In form they bear a close resemblance to the Colorado potato-beetle larvæ."

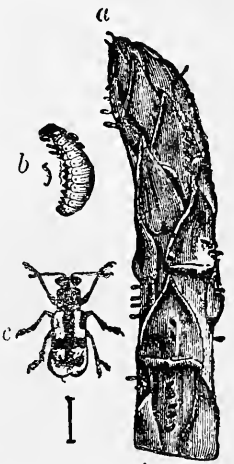


FIG. 106.—ASPARAGUS BEETLE.

a. Eggs on stalk. *b*. Larva. *c*. Beetle. *b* and *c*, magnified. (*Comstock.*)

The larvæ are of a dull gray or ash color with shining black

heads and six brownish legs. They feed upon the outer bark and even the tougher bark of the main stems. In about ten days from hatching they are full-grown, and then descend to the earth, pupating slightly below the surface. Ten days later, they emerge as beetles to feed upon the plants and to deposit eggs for another brood which emerges as beetles in autumn and hibernates through the winter.

Remedies.—In garden patches the eggs may be rubbed off before hatching, or if domestic poultry are allowed to have the run of the asparagus beds, the beetles will be greedily devoured. Pyrethrum powder has been used with some success, but the method employed by the Long Island asparagus growers is to extirpate all volunteer plants, and as the shoots of the regular crop are cut every few days the eggs of the beetles have little opportunity to hatch.

This treatment has been found the best practical method of holding the pest in check. Dr. Riley says (Bulletin, No. 23, December, 1893, Maryland Experiment Station): "A very light dusting of pyrethrum powder mixed with spoiled flour in the proportion of one to ten, is the cleanest and best way to treat the first larvæ observed, and even without insecticide substances the daily cutting off of all shoots upon which eggs are observed will serve to effectually check the work of the first brood. As it is the neglected later broods which rapidly multiply after the market season is over, which supply the hibernating beetles that damage the young shoots the following spring, it is quite important to treat these latter broods. All voluntary asparagus in the neighborhood of the beds should be rooted up and destroyed, and only a few plants should be allowed to grow. These will attract the beetles that are in the immediate neighborhood, and their larvæ may be killed in the manner already indicated, or by the use of kerosene emulsion, which, if repeated two or three times during July and August, will serve materially to prevent injuries the following spring."

THE CABBAGE.

THE IMPORTED CABBAGE WORM.

(*Pieris rapæ.*)

We have a native and a European species, both very destructive to cabbage and cauliflower. Carrots, mustard, radishes, turnips, mignonette, and nasturtiums are also, at times subject to their ravages.

The butterflies are much alike in appearance; the wings are gen-

erally white with indefinite black marks above, and with yellow or green markings on the under side.

The worms differ in color, the imported species being green while our native one is pale blue with yellow stripes. The eggs of both species are attached to the under side of the leaves and hatch in about one week. The young caterpillars of the imported species are pale yellow,

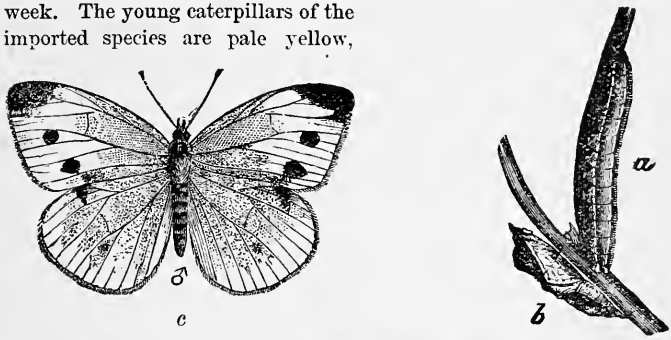


FIG. 107.—IMPORTED CABBAGE WORM.
a. Larva. *b*. Chrysalis. *c*. Male butterfly. (*Riley*.)

but as they grow older, change to a greenish color with a faint yellow line down the back and a row of yellow spots on each side. The full-grown caterpillar is from an inch to an inch and a quarter long. The winter is passed in the chrysalis stage hid away in sheltered places; the adult butterfly emerges in the spring and lays eggs from which the first generation is produced. Several broods develop during the season.

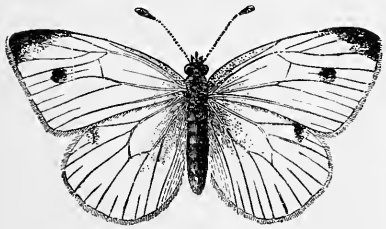


FIG. 108.—FEMALE. (*Riley*.)

The chrysalis is subject to the attacks of parasites which deposit their eggs within its body, and hatching before the time for the emergence of the butterfly, feed upon the dormant insect, causing its death.

Remedies.—We do not advocate the use of mineral poisons on cabbage except when the plants are very young. Pyrethrum powder or buhach, kerosene emulsion or hot water, may be used. Dr. Riley gives decided preference to hot water and says: "Every worm visible upon the cabbage may be killed by the use of hot water at the tem-

perature of 130° Fahrenheit. The water may be boiling hot when put into the watering-can, but it will not be too hot when it reaches the cabbage-leaves." Pyrethrum powder may be diluted with from 5 to 6 parts of flour and dusted over the plants with a powder bellows. One ounce of pyrethrum stirred into one gallon of boiling water and when cool, diluted with four gallons of cold water, makes a very effective insecticide for spraying cabbage and cauliflower.

Professor James Fletcher (Insect Life, IV, 13), says "In the treatment of cabbage caterpillars, pyrethrum diluted with four times its weight of common flour, and then kept tightly closed for twenty-four hours, leaves nothing to be desired, and thousands of dollars are yearly saved to small growers who most need assistance."

THE CABBAGE PLUSIA.

(*Plusia brassicæ.*)

The parent insect is a handsome night-flying moth of a dark smoky gray color, with a small silvery white spot and V-shaped mark near the middle of each front wing. The eggs are deposited singly or in clusters, generally on the upper surface of the leaves. The larvæ soon hatch into pale-green, translucent worms, marked with paler longitudinal stripes on the sides and back. They gnaw irregular holes in the leaves and burrow into the heads of cabbage. When full-grown the caterpillars are about two inches long. They are true spanworms and in traveling, the body assumes the looping position seen in the figure.

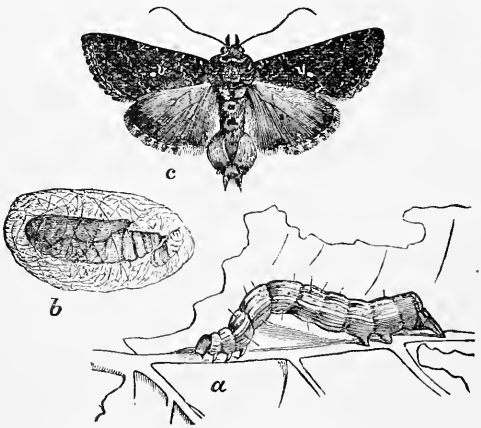


FIG. 109.—CABBAGE PLUSIA.
a. Larva. *b*. Pupa in cocoon. *c*. Moth. (*Riley.*)

The full-grown caterpillar spins a very thin, white, or semi-transparent cocoon generally on the under surface of the cabbage-leaf and

transforms to pupa, shortly afterward emerging as the adult moth. In the southern states there are several broods each season.

This pest is destroyed in vast numbers by toads and birds, and the larvæ are subject to the attacks of parasitic insects; it is also the victim of fungous disease, more especially in wet seasons.

Remedies.—The worms are very soft and tender and readily succumb to treatment with kerosene emulsion. Pyrethrum powder also kills them. It is most effectual used alone in powder or mixed with flour.

THE CABBAGE MAMESTRA.

(*Mamestra trifolii.*)

The moth ranges in color from a pale yellowish gray to a dark brownish, mottled gray. It is variable in size, resembling the Plusia moth from which it is readily distinguished by the absence of the bright, silvery spot on the front wings. The caterpillars vary from bright green to brownish green above, and are marked by a broad pink stripe on each side. Pupation takes place in an oval cavity underground.

Remedies.—Treatment the same as for the Cabbage Plusia.

THE ZEBRA CATERPILLAR.

(*Mamestra picta.*)

In the mature stage this insect is a handsome moth with rich purplish-brown front wings. The hind wings are white, and faintly edged with brown on the upper and outer borders. The body is grayish, the head and thorax purple-brown.

The eggs are spherical and are laid in clusters on the cabbage, cauliflower, and other food plants, early in summer. The larvæ when young are blackish, soon changing to light green. The young worms are gregarious, feeding together near the places where the eggs were clustered, but as they grow older they disperse over the plants. When full-grown the larvæ are about two inches long, marked by broad longitudinal velvety-black stripes on the back, and brilliant yellow stripes upon each side, connected by fine, transverse zebra-like lines as seen in figure 110. When disturbed the worm curls up and drops to the ground.

The full-grown caterpillar forms a rude cocoon of silk and earth in the ground and changes to pupa, emerging a fortnight later as the perfect moth. Two broods are developed yearly, the second hibernat-

ing through the winter and emerging as moths in the following spring. The spring brood attacks cabbage, cauliflower, beets, spinach, etc., and the autumn brood is often found on asters, asparagus, clover, honeysuckle and mignonette.

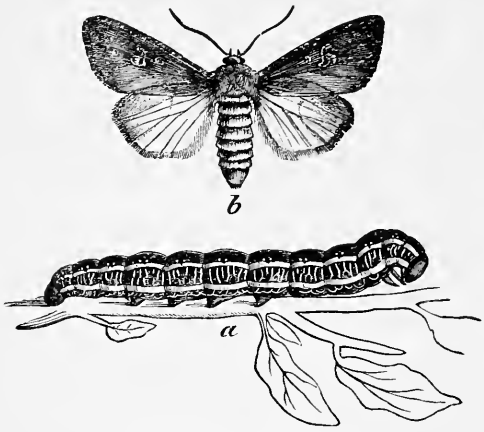


FIG. 110.—ZEBRA CATERPILLAR.
a. Larva. *b*. Moth. (*Riley.*)

Remedies. — The larvæ when young, cluster together upon the leaves and are easily disposed of by hand-picking. When the caterpillars have scattered over the plants they may be destroyed by spraying with kerosene emulsion, with decoction of pyrethrum or by dusting the plants with the powder by means of a powder gun. Spraying with hot water also kills the worms without injury to the plants.

THE HARLEQUIN CABBAGE-BUG.

(*Murgantia histrionica.*)

This is a tropical species, said to have been introduced from Mexico into Texas, from which state it has spread over the south and as far north along the Atlantic seaboard as Delaware. It increases with extreme rapidity and is now the worst insect enemy of cruciferous plants in the southern states. This insect derives its name from the gaudy colors and "harlequin-like manner in which the black and orange-yellow are arranged upon the body." In the southern states the insects live through the winter hidden under leaves and rubbish.

Dr. G. Lincecum, writing of the life history of the insect in Texas, says: "The perfect insect lives through the winter, and is ready to deposit its eggs as early as the 15th of March, or sooner, if it finds any cruciform plant large enough. They set their eggs on end in two rows, cemented together mostly on the under side of the leaf, and

generally from eleven to twelve in number. In about six days in April (four days in July) there hatch out from these eggs a brood of larvæ, resembling the perfect insects, except in having no wings. This brood immediately begins the work of destruction by piercing and sucking the life-sap from the leaves, and in twelve days they have matured. They are timid and run off and hide behind the first leaf-stem, or any part of the plant that will answer the purpose. The leaf that they puncture soon wilts * * * Half a dozen insects will kill a cabbage in a day."

FIG. 111.—HARLEQUIN CABBAGE-BUG.
f. Adult. *g*. Adult with wings extended. All natural size. (*Riley.*)

Remedies.—Infested fields should have clean culture, and all rubbish liable to furnish a refuge for the bugs during winter should be burned.

Hand-picking into pans or cans containing water or kerosene oil is resorted to in the south. Pyrethrum in powder or decoction and strong kerosene emulsion may prove effectual when the bugs are young. By far the most promising method of dealing with the pest is that of Professor H. E. Weed, of the Mississippi Agricultural Experiment Station. Wild mustard, when young and tender, is preferred by the bugs even to cabbage, and this is one of the earliest cruciferous plants to appear in spring. In 1891, Professor Weed killed the bugs upon the mustard plants with pure kerosene, but in 1892 he decided to sow mustard between the rows to be planted in cabbage. The majority of the hibernating bugs clustered upon the early mustard plants and were killed with pure kerosene; the cabbage escaped almost entirely from the depredations of the insects. We recommend this course to cabbage growers, wherever the pest is troublesome. Where mustard has not been provided, try spraying with a pretty strong pyrethro-kerosene emulsion.

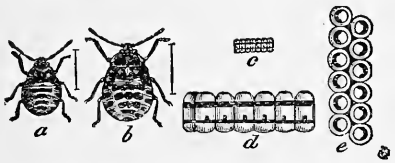


FIG. 112.—HARLEQUIN CABBAGE-BUG.
a, *b*. Nymphs. *c*. Eggs. *d*. Eggs, side view. *e*. Eggs, view from above. *d*, *e*. Enlarged. (*Riley.*)

THE CABBAGE MAGGOT.

(*Anthomyia brassicæ.*)

The adult, which appears about the time the plants are set out, is a two-winged fly somewhat resembling the common house fly. The eggs are laid on the stems of the young plants near the surface of the soil and soon hatch into small, whitish maggots, which work downward into the earth, feeding on the roots of the tender plants.

In about three weeks from hatching, the maggots pupate and in a few days emerge as adult flies. Three and probably more broods appear each season. This insect also attacks turnips and ruta bagas.

Remedies.—The maggots are easily destroyed by the use of kerosene emulsion about the roots. Dr. Riley has suggested the use of slaked lime or ashes as a probable remedy.

THE WAVY-STRIPED FLEA-BEETLE.

(*Phyllotreta vittata.*)

This little insect also known as the *Striped Turnip Beetle*, feeds upon the surface of the leaves of the cabbage, turnip, radish, etc. The adult is black or nearly so, with a broad, wavy, buff or yellowish colored, longitudinal stripe on each wing cover. The females lay their eggs upon the roots of the food plants, and the larvæ which are whitish or yellowish and semi-transparent, with horny brown heads, often do very serious injury to cabbage, turnips, radishes, and other vegetables.

Remedies.—Powdered tobacco or tobacco decoction are said to be good remedies. Drenching the roots with kerosene emulsion will destroy the larvæ. Dusting the plants with land plaster, lime and dry unleached wood ashes are also regarded as protections from this little pest.

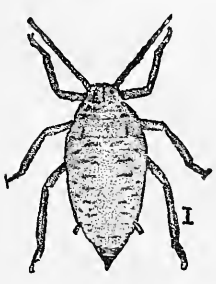


FIG. 113.—CABBAGE APHIS. Oviparous female, magnified. (*Weed.*)

THE CABBAGE APHIS.

(*Aphis brassicæ.*)

A small, light green insect, usually covered with a white flour or meal-like substance. In habits and life history this species resembles other aphides producing oviparous and viviparous young, which are developed on a variety of cruciferous plants.

Remedies.—Kerosene emulsion, 1 part to from 20 to 25 of water, readily kills this pest.

As the eggs are laid upon the cabbage leaves the refuse leaves should be fed to stock or poultry, and the stalks should be burned.

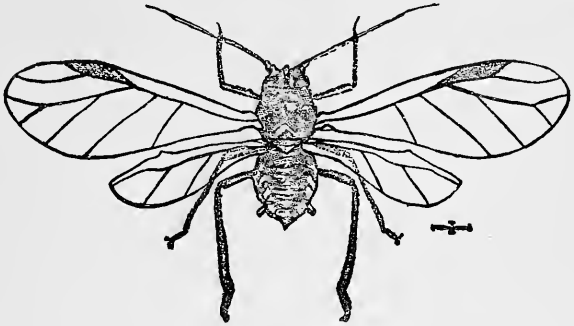


FIG. 114.—CABBAGE APHIS.
Male, magnified. (*Weed.*)

CELERY.

THE CELERY CATERPILLAR.

(*Papilio asterias.*)

The celery caterpillar or "parsley worm," as it is frequently called, is when full grown about an inch and a half long, of a pale, delicate green color, lightly gradated on the sides and with a series of transverse yellow markings on each segment of the body. When alarmed the worm thrusts out from a slit just back of the head, a pair of yellow V shaped horns, which are not stings as are generally supposed, but are the insect's organs of defence from which it diffuses a disagreeable odor.

FIG. 115.—CELERY BUTTERFLY. (*Weed.*)

The pupa is ash-gray, yellowish, greenish or ocher-yellow in color.

The period of pupation lasts from nine to fourteen days, when the insect transforms to a beautiful black butterfly marked by rows of yellow and blue spots on the wings.

FIG. 116.—CELERY CATERPILLAR AND BUTTERFLY. (*Weed.*)

The butterflies have an expanse of wing of from three and three-quarters to four inches.

The eggs are deposited singly upon the food plants of the larvæ, and hatch into small, blackish caterpillars, less than one-tenth of an inch long.

The caterpillars feed upon the leaves of the celery, carrot, parsnip, parsley and related plants.

Remedies.—Hand-picking is generally practicable since the caterpillars are usually never present in large numbers. The larvæ when young, are readily destroyed by dusting infested plants with pyrethrum powder, which may be diluted with from three to four parts of refuse flour.

THE CUCUMBER.

THE STRIPED CUCUMBER BEETLE.

(*Diabrotica vittata.*)

The parent beetle is a small, yellow insect, marked with black stripes on the back. It makes its appearance early in the season, having passed the winter concealed under leaves, rubbish, etc., and at once attacks young cucumber, melon and squash-vines. It feeds upon the leaves and stems, and at times is so destructive that plants subject to attack cannot be grown, unless carefully guarded from the pest. Nor are the depredations of the parent beetles alone all that must be guarded against.

FIG. 117.—ADULT STRIPED CUCUMBER BEETLE.

After the beetles begin to decrease in numbers, and sometimes after they have entirely disappeared, the vines begin to wilt and die.

If we examine the roots of dying vines, we find the corroded roots pierced by minute holes, in which are often imbedded slender, whitish worms with brown, horny, flat heads. These are the larvæ of the striped cucumber beetle.

The worms are full grown in about a month from hatching, and are then slightly less than half an inch long.

They now leave the roots, make a little cavity in the earth near by, cast their larval skins and transform to pupæ.

The insect spends the winter in the beetle state, concealed under

leaves, logs, or rubbish, and comes forth in early spring to renew its depredations.

Remedies.—One of the best remedies against this pest is the liberal use of tobacco dust in and upon the hill. The tobacco acts not only as an insecticide but also as an excellent fertilizer. For small patches or the family garden an excellent protection for the young plants may be had by providing gauze-covered frames to exclude the beetles. Such frames are readily made out of old barrel hoops. The hoops should be cut in half and placed crosswise over the plants, with the ends fastened in the ground; over the dome-like frame thus made stretch a covering of cheese cloth or mosquito netting.

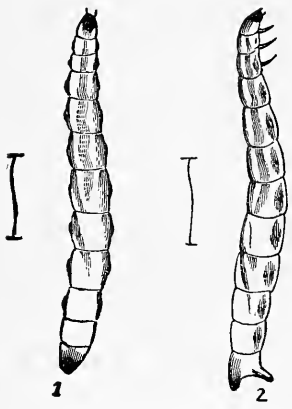


FIG. 118.—LARVA.
1. Back view. 2. Side view. (*Riley.*)

The beetles are thus excluded, while air, sunshine and moisture, have free access to the tender plants.

The earth should be drawn over the edges of the gauze to prevent the beetles from crawling under and onto the plants. These frames are readily removed for cultivation and as readily replaced.

Bits of blotting paper or rags saturated with oil of turpentine, scattered about the vines and stems are said to be obnoxious to the beetles and to drive them away.

THE CUCUMBER FLEA BEETLE.

(*Crepidodera cucumeris.*)

This is a small black or darkish beetle that appears early in the season and eats little round patches from the upper surface of the leaves of young squash and cucumber plants.

The larvæ are believed to burrow into the leaves.

Remedies.—Powdered tobacco dusted over the vines is an efficient remedy.

THE ONION.

THE ONION MAGGOT.

(*Anthomyia ceparum.*)

This is the larval stage of the Imported Onion Fly, a closely related species to the native American Onion Fly (*Ortalis arcuata*) and the Black Onion Fly (*Ortalis flexa*).

These species resemble each other in habits, and are subject to the same remedial treatment. The female deposits her eggs in spring on the small bulbs, or leaves near the ground. The eggs hatch in about a week into dull whitish maggots that burrow through the bulbs to their bases. When fully developed, which is in about a fortnight, the maggots are not quite half an inch long and pointed at the head end. They then leave the bulbs, enter the earth and change to chestnut-brown pupæ. The flies appear in about two weeks and lay the eggs for another brood.

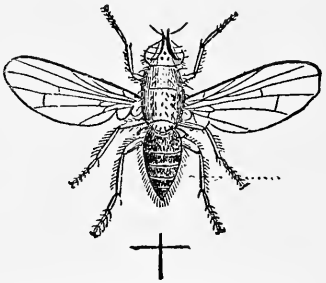


FIG. 119.—FLY OF THE ONION MAGGOT.

Remedies.—When the sickly or yellow color of the plants indicates the presence of the onion maggot, the bulbs should be taken out with a knife or trowel and the infested onions destroyed. Possibly drenching the bulbs with kerosene emulsion would prove effective. Salt, at the rate of from 2½ to 3½ bushels per acre, has also been used when the plants were young. Possibly the best preventive measure is that suggested by Prof. Cook, which is to plant the crop on land at some distance from that occupied by onions the preceding year.

THE POTATO.

THE COLORADO POTATO BEETLE.

(*Doyphora decemlineata.*)

The native home of the Colorado potato beetle is the eastern declivities of the Rocky Mountains. This insect, so familiar to every farmer, was first described in the "Journal of the Academy of Natural Sciences," of Philadelphia, in 1824, by the noted naturalist,

Thomas Say, who accompanied Long's exploring expedition to the Rocky Mountains. Say found the insect not uncommon in the region of the Upper Missouri, and it was afterward ascertained that the original food of the beetle was the sand-bur (*Solanum rostratum*), a species of wild potato indigenous to the Rocky Mountain regions. With the westward march of civilization came the white potato, and its culture in the native home of the species gradually led the way to the introduction of the pest throughout North America, and thence to the Old World.

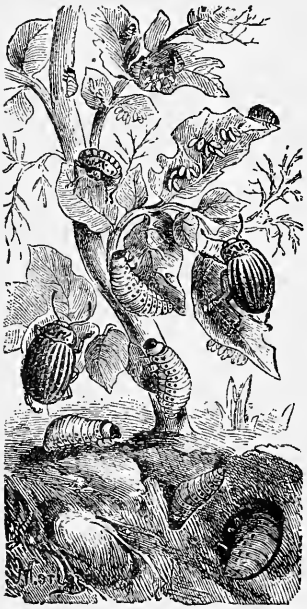


FIG. 120.—COLORADO POTATO-BEETLE IN ALL STAGES.

The insect gradually began its advance eastward. According to Dr. Riley, it was known in eastern Nebraska in 1859. In 1861 it invaded Iowa; had crossed the Mississippi in 1864, and in 1874 had reached the Atlantic States, from whence it was carried to Europe.

This insect needs no description here. The orange-colored eggs, varying in number from a dozen to fifty, are laid on the under side of the potato-leaf. The eggs hatch in about a week into sluggish larvæ which feed upon the leaves, never leaving a plant until it is completely defoliated, and then only for food. The tomato and egg-plant are also fed upon to some extent by this insect.

In addition to these plants, Dr. Riley enumerates the ground cherry, thorn apple, henbane, apple of Peru, tobacco, belladonna, petunia, cayenne pepper, and cabbage, as being occasionally liable to attack.

When fully developed, the larvæ pupate just beneath the soil or under rubbish above the surface.

The insects fluctuate greatly in numbers and in destructiveness from year to year. "It spreads," says Dr. Riley, "but does not travel in the sense of leaving one district for another." There are from two to four broods each season.

Remedies.—The arsenites, Paris green, and London purple, are almost universally used for combating this pest. They may be applied in liquid suspension, or in powder diluted with about fifty times their weight of flour, sifted ashes, or road dust, or with one hundred pounds of land plaster.

The writer prefers a liquid insecticide and uses from four to six ounces of Paris green to fifty gallons of water, to which a pint of glucose, or syrup, or a quart of flour paste is added.

A half teaspoonful of Paris green and a half pint of kerosene emulsion to a two-gallon pail of water makes an excellent mixture for use

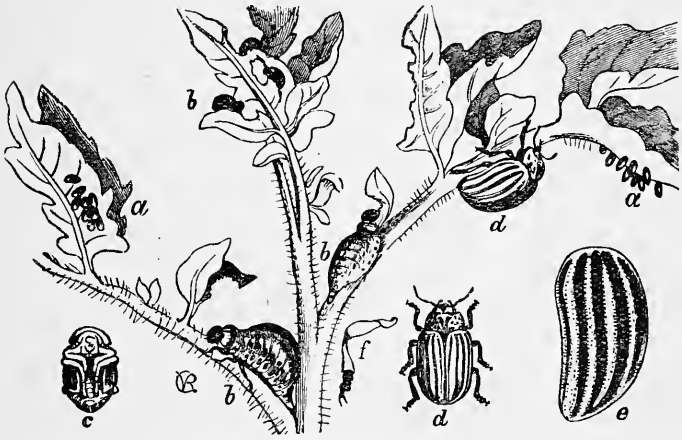


FIG. 121.—COLORADO POTATO-BEETLE.

a, *a*. Eggs. *b*, *b*. Larvæ. *c*. Pupa. *d*, *d*. Beetles. *e*. Wing of beetle, magnified. (*Riley*.)

on garden plots. The adult beetle avoids plants sprayed with a mixture containing kerosene, and will not deposit eggs upon them, and the emulsion serves also to destroy the vitality of the eggs.

The arsenites may be dusted over the foliage with a powder-gun or perforated can; or in suspension, may be applied with a spraying machine or ordinary watering-pot.

Peroxide of silicate, etc., and many proprietary preparations, which owe their efficiency to arsenic, are advertised throughout the country. Spraying is decidedly the cheaper method of applying arsenites for this pest and should be begun as soon as the beetles appear.

THE POTATO OR TOMATO WORM.

(*Phlegethontius celeus.*)

The parent of this pest is a beautiful sphinx moth nearly related to the Carolina Tobacco Sphinx (*Phlegethontius carolina*), described on page 165.

The Potato or Tomato worm is of northern distribution, and is perhaps more destructive to the tomato than the potato ; it is the tobacco worm of northern latitudes, and the two species were formerly confounded with each other. Both moths have orange-colored spots on the sides of the abdomen, but in the wing markings there are perceptible differences. In the present species the general color of the body and wings in the adult is grayish, marked by stripes and dots in gradated shades of grayish brown, with a faint white spot near the center of each front wing.

The moths fly about dusk, lapping up the nectar of flowers through their long, slender sucking tubes or tongues. The adults appear early in summer, and the females lay their eggs in the evening on the leaves of the potato and tomato. The worm, or caterpillar, is a voracious feeder and soon makes its presence known by stripping the stems of foliage and by the abundant castings on the ground below. The caterpillars grow rapidly and in a few weeks are about three inches long and of the thickness of a man's little finger. Their color is light green or brown with oblique, whitish stripes on the sides of the body. When full-grown, which, in the northern States is early in September, the caterpillars retire to the earth, where they make oval cells some distance below the surface, and transform to pupæ, in which condition they remain until the following summer, when they come forth as moths.

The caterpillar is subject to the attacks of a small parasitic, four-winged, black-fly which deposits its eggs within the worm. These eggs hatch into little maggots which feed upon the juices of the body, developing at the expense of the worm.

The worms infested by this parasite may be readily known by their emaciated appearance and the little, egg-shaped cocoons of white silk which the larvæ spin upon the backs of their hosts and in which the pupal period of the parasite is passed. Such caterpillars should never be destroyed, for although they linger for some time, they will do but little harm and will never complete their transformations. The little flies will soon emerge and continue the work of destroying the noxious species.

Remedies.—In the northern tobacco fields the same methods of

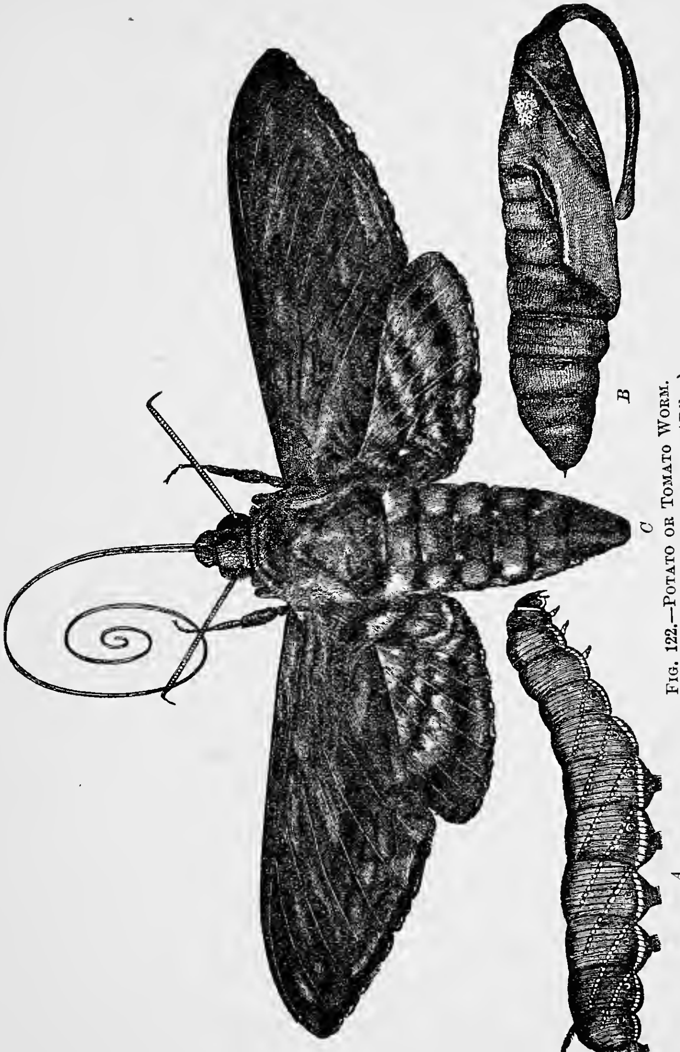


Fig. 122.—Potato or Tomato Worm.
A. Larva. *B*. Pupa. *C*. Moth. (*Riley.*)

fighting the pest should be employed as are used by southern planters, for destroying the Carolina Tobacco Worm (see page 165). In potato fields one of the best ways of killing the moths is to take shingles or old pieces of tin or boards and nail them to strips of wood which may be driven into the ground as supports. The boards or shingles should be supported from one to two feet from the ground and smeared with molasses mixed with a little poisoned water, to which some whisky or malt liquor has been added.

BLISTER BEETLES.

(*Meloidæ.*)

Several species of beetles belonging to the same family as the Spanish-fly of commerce, attack the potato. Dr. Riley thus describes these curious insects: "These insects all agree in possessing vesicatory (*blistering*) powers, and in their curious life-history. Harris and many other writers believed that their larvæ lived underground upon the roots of plants; but it is now fully established that they agree with many other members of the family, as, for instance, the oil-beetles (genus *Meloë*), in leading in their younger days a partly parasitic and partly predaceous life; and when this is remembered, the fact that some of the beetles have been observed to feed upon Doyphora larvæ, becomes less surprising. The female Blister-beetle is very prolific, her abdomen greatly swelling in pregnancy. She lays her eggs in masses in the ground and carefully covers them up. These hatch in a few days into minute, light-brown, bristly creatures with six long legs, two long bristles at the tail, and prominent jaws. They run about with great activity, mount different composite flowers frequented by bees, throw themselves onto the bodies of these whenever they get the chance, and by tenaciously clinging to their hirsute host, are carried into its nest. Here, as the female bee is about to lay an egg in the cell prepared for it, the blister-beetle larva drops into the cell. Floating for a while on the surface of the honey and feeding thereon, it molts a few times, each molt representing a loss of activity by reduction of the legs, until at last the active hexapod is changed into a clumsy, legless maggot which fastens to the bee-larva that had meanwhile developed. In a short time this last is devoured, and then the blister beetle larva goes through those curious transformations known as hypermetamorphoses, the larva transforming to the pupa within its old skin, and the beetle finally issuing therefrom. The oil-beetle (Meloë) preys in this manner upon the common hive-bee, and aside from the injury done to the bee-brood, as just described, its larvæ

when first hatched sometimes so crowd on and worry the mature bees, as to cause death. The blister beetles, however, so far as we know, prey only on our wild, solitary bees, such as those belonging to the genera Andrena and Halictus."

THE STRIPED BLISTER BEETLE (*Epicauta vittata*).—It is in the adult condition that this insect feeds upon the leaves of the potato and occasionally on the foliage of the tomato. It has a slender body, marked on the wing-cases with black stripes alternating with slender lines of yellowish brown. The eggs are laid in masses in the ground, near the surface; the larvæ hatch in about ten days and at once begin to burrow through the soil in search of the eggs of grasshoppers upon which they feed. Dr. Riley says this species prefers most other kinds of potato tops to the Peach Blow. In southern Pennsylvania it is quite common on beets, carrots and the aster.

FIG. 123.—STRIPED BLISTER BEETLE. (*Riley.*)

THE ASH-GRAY BLISTER BEETLE (*Lytta cinerea*).—Dr. Riley says of this species: "It is the one commonly found in the more northern parts of the northern states, where it usually takes the place of the striped species. It is of a uniform ash-gray color, but this color is given it by the presence upon its body of minute ash-gray scales or short hairs, and whenever these are rubbed off, which happens almost as readily as on the wings of a butterfly, the original black color of its hide appears. It attacks not only the potato vine, but also the honey locust, and especially the English Windsor bean, and I have found it quite abundant on early snap beans. It is very injurious to lucerne, also attacks the foliage of the apple tree and likewise gnaws into the young fruit."

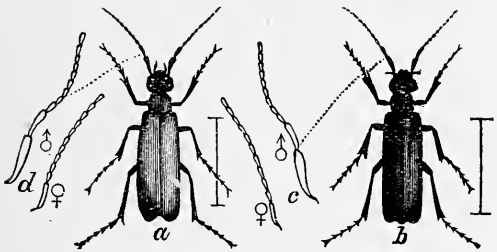


FIG. 124.—GRAY (*a*) AND BLACK-RAT (*b*) BLISTER BEETLES, WITH THE ANTENNÆ ENLARGED. (*Riley.*)

THE BLACK-RAT BLISTER BEETLE (*Lytta murina*); the BLACK BLISTER BEETLE (*Lytta atrata*); the MARGINED BLISTER BEETLE

(*Lytta marginata*); the WHITE BLISTER-BEETLE (*Lytta albida*); and the SPOTTED BLISTER-BEETLE (*Lytta maculata*), all at times prove destructive to the potato.

Remedies.—These species are not so readily destroyed by Paris green as the Colorado potato beetle, and it is questionable if insects so destructive to more injurious species should be molested unless they appear in numbers which seriously threaten a crop.

"In the extensive beet fields of the West," says Dr. Riley, "it is the custom, when these insects are abundant, to send men or boys through the field, working with the wind, and driving the beetles before them by short flights. On the leeward side of the field, windrows of hay or straw have been previously placed, and into these the beetles are driven and then burned."

THE POTATO-STALK WEEVIL.

(*Trichobaris trinotata.*)

This pest is the larva of a small snout-beetle of wide geographical distribution, but was unknown to Dr. Harris, in New England.

It is quite common in Pennsylvania and in many of the western states. According to Prof. Gillette, seventy-five per cent. of the crop in 1890 was infested by this insect in Iowa.

The female beetle places a single egg in a slit about an eighth of an inch long, made in a stalk near the soil.

The egg soon hatches into a small, yellowish-white or whitish grub, that tunnels into the heart of the stalk, burrowing downward toward the root and causing the plant to wither and the premature death of the vine. When fully grown the grub is a little over one-fourth of an inch long, yellowish-white in color, legless, and the head has a scaly appearance.

In a few weeks the grub pupates within the stalk below the surface of the soil, and emerges as an ash-gray or bluish beetle later in summer, or early in autumn. The insect hides in any protecting rubbish during the winter and appears the following spring when the eggs are laid for another generation.

Remedies.—Whenever the presence of the larvæ is indicated by the wilting and dying of the vines, they should be pulled up and burned.

Even after harvesting the late crop, the vines should be burned if the pest has been at work in the field.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus.*)

A small silvery-white beetle with distinct markings on the back.

This species feeds on the stems and foliage of many vegetables, including potatoes, beets, radishes, onions, beans, and corn. It also attacks the fruit and foliage of the apple, cherry, and gooseberry. When alarmed, the beetles feign death.

FIG. 125.—IMBRICATED SNOUT-BEETLE. (*Comstock.*)

Remedies.—Paris green and London purple may be used, either in powder or liquid suspension, for destroying this pest. These poisons should not be used on fruit trees or vegetables, except in cases where they may be employed with absolute safety.

RHUBARB.

THE RHUBARB CURCULIO.

(*Lixus concavus*).

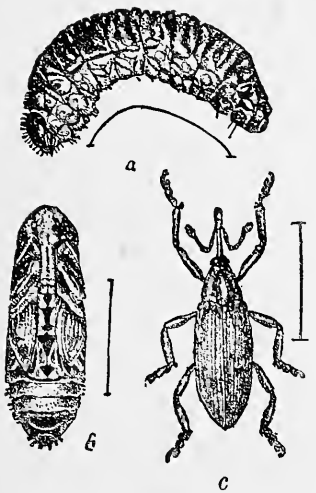


FIG. 126.—RHUBARB CURCULIO.
a. Larva. *b*. Pupa. *c*. Beetle, slightly magnified. (*Weed.*)

The parent beetle usually has a yellow appearance, due to a yellowish powder which covers its body. When this powder is rubbed off the insect is of a dull, grayish-brown color. The adult hibernates during the winter and appears early in the spring, laying its eggs in certain common species of dock, as for example the yellow dock (*Rumex crispus.*)

The eggs are also deposited in the stalks of the Rhubarb, but it is thought the insects are incapable of development, except in the wild dock. The beetles, however, gnaw and tunnel holes in the stalks of the rhubarb, causing the sap to exude, and thus do much injury to the plant.

Remedies.—Hand-picking the beetles is the only known remedy. The wild dock, wherever abundant, should be dug up and burned.

THE SQUASH.

THE SQUASH-VINE BORER.

(*Ægeria cucurbitæ.*)

The squash-vine borer is the larva of a moth belonging to the same genus as the Peach borer. The parent insect has an orange colored body; the fore-wings are black or olive brown, and the hind ones transparent; the hind pair of legs are fringed with long orange-yellow and black hairs. The eggs are laid on the stems of the young plants near the roots of the cucumber, squash and melon, and the larvæ on hatching, burrow into the stems, feeding upon their substance and causing the plants to die.

The full-grown borer measures about one inch in length, is whitish in color, with the head brown.

Toward the close of summer the borers leave the upper part of the root or the stem near the surface, construct rude cocoons or cells, composed of earth glued together with a gummy silk-like secretion and enter upon the pupal stage of life. The moth emerges the following spring.

Remedies.—All withered or dead vines should be destroyed in order that the larvæ may not escape to propagate their kind. Covering several of the lower joints with earth has also been suggested for the purpose of inducing the vines to take root at these points, since the borer deposits her eggs on the stems near the roots. Cutting out the larvæ whenever suspected is also resorted to. Sprinkling or dusting with Paris green near the roots is also said to be effective in preventing the ravages of this pest.

THE SQUASH BUG.

(*Anasa tristis.*)

This insect makes its appearance in our more northern latitudes late in June, and the females deposit their small, spherical, brownish-yellow eggs on the under side of the leaves in patches of from three to a dozen together.

The eggs soon hatch into pale, ash-colored larvæ, or nymphs, that insert their slender, pointed beaks into the leaves and suck the sap.

The nymphs at first remain in small swarms, those from a single brood feeding together; but as they grow older, moult their skins several times, and scatter over the plants. Like all other true bugs they do not have complete transformations and have no quiescent or

dormant pupal stage. The nymphs bear considerable resemblance to the adults, a resemblance that becomes more evident as the insects approach maturity.

The adult is a little over half an inch long, rusty black above and of an ocher-yellowish color beneath. When disturbed or handled this insect emits a disgusting odor, somewhat like that given off by the bed-bug and chinch-bug. The adult passes the winter secluded under logs, leaves, boards, or any rubbish that affords protection.

FIG. 127.—SQUASH BUG.

Remedies.—Hand-picking during the morning or in the evening hours when the bugs are less active, is the most practical way of keeping them in check.

The nymphs are quickly killed by applications of kerosene emulsion, in fact several sprayings with this insecticide kills many of the parent bugs and causes the others to leave the vines.

Boards laid among the plants have been used by Professor Cook as traps to catch the bugs. The insects collect under the boards at night and are destroyed early in the morning.

SUGAR BEET.

THE SUGAR BEET WEB-WORM.

(*Loxostege sticticalis.*)

The life history of this insect has not yet been fully studied but there are certainly two annual broods and probably three or four.

The eggs are pale yellow, slightly polished and somewhat iridescent; they are deposited "singly, or in rows of from two to five or more, in the latter case overlapping each other like scales. The young larvæ are whitish in color with polished black heads. The full-grown larvæ are yellowish-white with a broad black medio-dorsal stripe, and a still broader sub-dorsal stripe, the two fine lateral lines being also black. * * * * The head is yellowish or marbled with black." (Rep. U. S. Dept. Agr., 1892).

Remedies.—Paris green, Persian insect powder and white hellebore were tried on infested plots at Schuyler, Nebraska, where the pest caused some alarm in 1892. Paris green was applied in the proportion of one teaspoonful to a gallon of water and the insect powder and white hellebore were sprinkled as powders by hand over the beet tops.

The efficiency of Paris green and of Persian insect powder, seem, from these first experiments, to be fully established. White hellebore was without effect. "The web-worms were most abundant at a distance from sheltered localities, bordering groves, and were most numerous upon high ground, hill-tops and slopes, rather than upon flat ground. They were never plentiful on a piece of ground planted to beets for the first time, unless it adjoined one that was cultivated in beets the year before. They were more abundant in the middle of large fields than in small ones, and also in fields that were allowed to run to pig weed (*Amarantus*, sp.) the preceding year than in fields where the weeds were kept down. Sandy soil was apparently more favorable to their increase than heavier soil."

For the full report on the Sugar Beet Web-worm, see pages 172–175, Rept. U. S. Dept. Agr., 1892.

CORN.

THE CLAY-COLORED BILL-BUG.

(*Sphenophorus ochreus.*)

Several species of beetles, commonly known as bill-bugs, are destructive to corn, but the habits and life history of each species are much the same, and in their attacks on this crop produce injuries of like character. The clay-colored bill-bug is one of the most prominent beetles of the group, conspicuous by reason of its large size and light clay color. The larva is a large, whitish, wrinkled grub with a small brown head and without feet. The grub burrows into the bulbous roots of reeds, rushes and other swamp-growing plants which are its natural foods.

In "Insect Life," November 1889, Professor F. M. Webster says:—

"The insect passes the winter in the adult stage, coming forth from its hiding places in spring and feeding upon the tender portion of the stems of the reeds and rushes, and later on the same parts of the young corn plants, if the field has been planted to that grain. Late in May and early in June the female deposits her eggs in or about the bulbous roots of the *Scirpus*, the roots of this plant consisting of bulbs connected by smaller slender roots. The larva burrow into these bulbs which are many of them the size of an ordinary hen's egg and very hard, and transform to the adult beetle therein, appearing on the rushes, reeds, or corn in August and September, and feeding after the manner of their ancestors. The large size of the larvæ and the diminutive size of the corn at the period of oviposition renders it very

unlikely that this species will ever breed in the roots of corn, and, indeed, no trouble has been experienced after the natural flora of the land has been eradicated."

Remedies.—Professor Forbes, State Entomologist of Illinois, states :—"Elaborate experiments made at the office and on the university farm, failed to show that this beetle could breed in corn. Hills of corn with which imagos had for several weeks been enclosed and upon which they fed with the greatest freedom, were not infested with the larvæ of this species, neither could eggs be found upon or about them, although the beetles were pairing when imprisoned."

From these observations it would appear that there is little danger of this species becoming a pest to corn, except in recently drained or swampy fields, or on those adjacent to low, marshy lands where the reeds and rushes abound which furnish the natural food for the immature insects. Therefore recently drained or low, wet lands, to be planted to corn should be broken up early in the previous summer, before the middle of June or first of July, so as to prevent, as much as possible, the growth of larvæ and to destroy for the future the food of the mature insects should they appear the following spring.

Of this method of dealing with the pest Professor Webster says :—"At the commencement of investigations, and after learning the habits of the larvæ, it looked as though breaking the ground in June or July and throwing roots and larvæ up to the scorching rays of the midsummer sun might destroy the pest. But having reared adults from the eggs in bulbs kept in dry earth from the middle of June to the 25th of August, it would seem that little can be accomplished in that direction, and the only plan which now promises success, is to destroy all traces of their native food plants long enough before planting to corn to starve the adults, or compel them to seek other uncultivated localities."

THE CORN CURCULIO, OR BILL-BUG.

(*Sphenophorus zea.*)

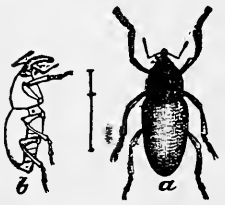


FIG. 128.—CORN BILL-BUG. *a*. Back view. *b*. Side view.

A semi-aquatic snout-beetle much resembling the peach and plum curculio. The adult beetle is of an ashen-gray color and about one fourth of an inch long. The female bites into the young plants near the ground and deposits her eggs in the cavity thus made ; the grubs which soon follow bore into the pith, killing the plant or causing it to remain in a dwarfed or unthrifty condition.

Remedies.—This insect is rarely troublesome on drained or well tilled land. It passes the winter concealed under the stalks or under stubble left on the field. Drainage, where needed, and thorough clearing fields of rubbish, cornstalks, or stubble, which should be burned, are the only known remedies.

THE BOLL-WORM.

(*Heliothis armigera.*)

The boll-worm of the cotton belt and the *corn-worm*, or *bud-worm* of the northern states is the same insect. The young worm varies in color from a deep dark brown to pale green.

When full-grown there is greater uniformity in appearance, though the variations in color are still strikingly different. When full-grown

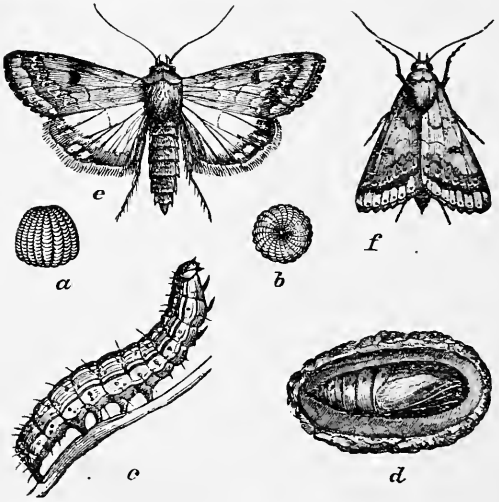


FIG. 129.—BOLL-WORM.
a, b. Egg. *c.* Larva. *d.* Pupa. *e, f.* Moth with wings expanded and closed. (*Riley.*)

the worm retires to the ground and envelops itself in a cocoon composed of earth interwoven with silk. The pupa lives through the winter in the soil, unaffected by severe freezing.

The moth lays her eggs on the boll, leaves or stems, and the worms, when hatched, bore into the boll and feed upon the lint. The ravages of this pest are not confined to cotton and corn alone, but the worm is

also known to attack green peas, string beans, pumpkins, tomatoes and gladioli.

Remedies.—In the cotton fields the moths may be killed in large numbers by means of lantern-traps, in the same manner as the cotton-caterpillar moths. (See page 168.)

"All the remedies," says Professor McCarthy, "used against the cotton-caterpillar will serve equally as well for the boll-worm. But the boll-worm begins its ravages long before the cotton moth, and when the worms are once inside the boll they cannot be reached by poisons. Therefore, when the boll-worm abounds the use of poison must begin as soon as the flowers have withered." (Bulletin 78, North Carolina Experiment Station.)

This pest prefers corn to cotton, and if a row of corn for every ten or a dozen rows of cotton be planted in the field, the moths will lay their eggs on the corn, from which the worm may be picked and destroyed.

THE WESTERN CORN ROOT-WORM.

(*Diabrotica longicornis.*)

A grass-green beetle, the larva of which does no little damage to the roots of corn in many of the western States. The larva is a slender, white worm which attacks the roots, burrowing toward the stalks. Pupation takes place within the soil during mid-summer and a few days thereafter the beetles emerge. "The beetles climb up the stalks," says Professor Forbes, "living upon fallen pollen and upon the silk at the top of the ear, until the latter dries, when a few of the beetles creep down between the husks and feed upon the corn itself, while the others resort for food to the pollen of such weeds in the field as are at that time in blossom." The eggs are deposited in the corn-ground in autumn and hatch the following spring.

Remedies.—Rotation of crops seems to be the only practical remedy. When the pest makes its appearance in corn-fields the land should be planted to some other crops the succeeding spring. The hatching larvæ will then starve for want of suitable food. The presence of the beetles among the corn in autumn should be a a sufficient warning to the farmer to plant the next year's crop on other land.

SOUTHERN CORN ROOT-WORM.

(*Diabrotica 12-punctata.*)

A slender white worm resembling the western corn root-worm to which it is nearly related. There are two broods each season, the eggs for the first brood being deposited about the corn roots and the

base of the stalk, by the adult, which is a small yellow beetle marked with twelve black spots upon the back. The beetles feed upon a great many wild and cultivated plants; cucumbers, melons, squashes, all suffer greatly from the depredations of this pest. The first brood of larvæ is the one most destructive to corn. The adult is also called the Twelve-spotted Cucumber-beetle.

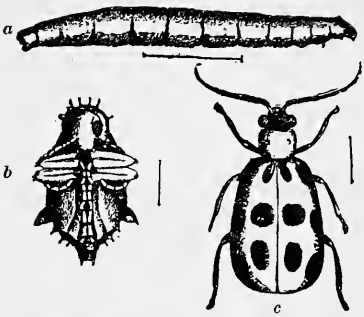


FIG. 130.—SOUTHERN CORN ROOT-WORM.
a. Larva. *b*. Pupa. *c*. Beetle. Magnified. (*Garman.*)

Remedies.—The arsenites might be tried upon young corn and also on melon, cucumber, and squash vines, when the plants are young. Pyrethrum powder, tobacco dust and possibly kerosene emulsion might be used effectively in gardens and on small patches, but on a large scale no practical method of treatment has been suggested.

THE STALK-BORER.

(*Gortyna nitela.*)

Also known as the Potato Stalk-borer. The larvæ of this insect infest a number of plants, among which are tomatoes, potatoes, Indian corn, dahlias, asters, lilies, salvia, rhubarb, spinach, cocklebur, and the twigs of the apple, peach, blackberry, and currant.

The adult is a brown moth belonging to the group of insects to which the cut worm moths belong. The moths appear late in summer or early in autumn.

FIG. 131.—STALK-BORER.
1. Moth. 2. Larva. (*Riley.*)

Remedies.—Wherever the larvæ are found they should be destroyed. Their habit is to cut off the terminal leaves within the stalk, thus causing the leaves to wither and die. As the insect is

propagated largely upon weeds, crops liable to injury should have clean culture.

THE GARDEN WEB-WORM.

(*Eurycreon rantalis*).

The parent is a small, gray moth with a wing expansion of about three-fourths of an inch. The eggs are deposited on the leaves and stems of several plants, including Indian corn. The larvæ spin a protecting web underneath which they feed upon the leaves.

At first only the upper surface of the leaves is eaten, but as the worms grow older the entire leaf is devoured. Pupation takes place in the ground, in thin, brownish cocoons.

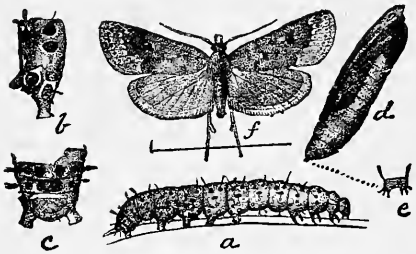


FIG. 132.—GARDEN WEB-WORM.
a. Larva. *d*. Pupa, both twice natural size. *f*. Moth, slightly enlarged. (*Riley*.)

Remedies.—It is only occasionally that this insect does severe injury to crops. Dust or spray the plants with the arsenites wherever the pest is present in formidable numbers.

THE CORN-ROOT APHIS.

(*Aphis maidis*.)

The corn-root aphis is a small, bluish-green louse, nearly related to the apple aphis, and is found on the roots of Indian corn throughout the entire season. There are two forms, one winged and the other wingless, and like other aphides this species lays eggs and gives birth to living young. The lice suck out the sap of the corn roots, causing infested plants to turn yellow and have a sickly, unthrifty appearance.

Remedies.—No artificial remedy is known for this pest. In small garden patches, kerosene emulsion might be used for drenching about the roots, but treatment with this insecticide has not been regarded as practicable on a large scale.

In field culture a rotation of crops is the only preventive measure that can be suggested.

THE CORN APHIS.

(*Aphis maidis.*)

This insect is nearly related to the preceding species, and was for a long time regarded as the aerial form of the corn-root aphis, but these insects are now believed to belong to different species.

The life history of the corn aphis has not been very fully studied, but the winged females are known to appear upon the corn early in summer and to give birth to wingless living young which continue to multiply rapidly until autumn, when a winged brood appears which migrates to other plants.

Remedies.—These plant lice are held in check by parasitic enemies and by certain predaceous insects, such as Lady-beetles and Harvest-spiders. Artificial remedies are rarely if ever resorted to. The use of kerosene emulsion may sometimes be found practicable, that is, in garden patches.

CUT-WORMS.

The true cut-worms are the larvæ of several night-flying moths belonging to the genus *Agrotis*. The adults appear late in summer; they are dull gray or brown with a wing expanse measuring from one and a half to two inches. The wings are marked by two light or whitish spots, one round and the other kidney-shaped.

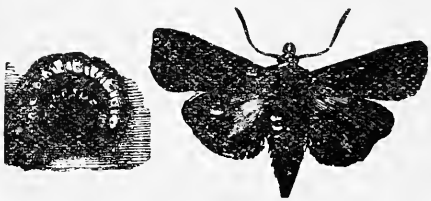


FIG. 133.—THE LARVA AND ADULT OF THE DARK-SIDED CUT-WORM. NATURAL SIZE. (*Garman.*)

The female deposits her eggs mostly late in summer, but occasionally in the spring. The eggs soon hatch and the larvæ enter the ground and live on the tender roots of grasses and other plants until the approach of cold weather, when they descend deeper into the earth and remain in a torpid condition through the winter. In spring they come to the surface and feed by night on a variety of succulent plants.

Several species of cut-worms are known, among which are the greasy cut-worm, the dingy cut-worm, the glassy cut-worm, and the climbing cut-worm.

Remedies.—Cut-worms are most injurious in sod-land or in fields

adjacent to grass land. Birds, especially robins, destroy them in vast numbers when exposed by the plow. The worms generally feed at night and hide through the day under clods, etc., near the places of their depredations. In gardens they may be dug out and destroyed, but in fields a little fresh clover cut in the evening and dropped in water containing Paris green or London purple should be scattered among plants. On sod-lands plowed under for other crops and in fields where cut-worms are suspected in disastrous numbers, use an abundance of seed, that a good stand may be left after the depredations of the worms are over.

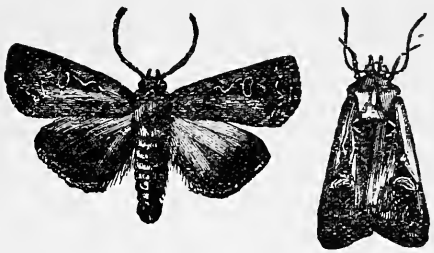


FIG. 134.—THE ADULT MOTH OF THE DINGY CUT-WORM. (*Garman.*)

THE GREASY CUT-WORM.

(*Agrotis telifera.*)

The larvæ of the moth or "miller" so common in lighted rooms during spring and summer evenings. The female moth lays her eggs on grasses, weeds, etc., and the larvæ hatch out in a day or two. The worms drop to the ground and burrow into the soil, feeding upon the roots of grasses, etc., until the approach of cold weather, when they descend deeper into the earth, remaining in a torpid condition through the winter. With the return of spring they come to the surface and devour whatever plants chance to be within reach.

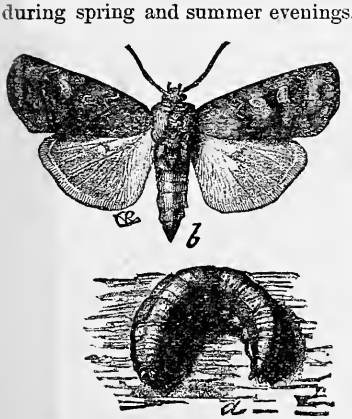


FIG. 135.—GREASY CUT-WORM AND MOTH. (*Riley.*)

Remedies.—This troublesome pest attacks a great variety of cultivated plants, and is especially destructive to tobacco, corn, and tomatoes.

Lantern traps will destroy many of the moths; several species of insects prey upon the worms and birds devour them in large numbers. Wrapping a piece of stiff paper around the stem of each plant, so that the lower edge of the paper will extend slightly below the surface of the ground, while the upper edge reaches an inch or two above the surface, is a sure protection to the plants, and is practicable in the home garden.

Professor Gerald McCarthy, Entomologist of the North Carolina Experiment Station, gives the following method for combating this pest in tobacco fields. "For destroying the worms the best method is to prepare loosely tied balls of fresh clover or cabbage leaves moistened with a paste of Paris green or white arsenic and flour. Place these balls about twenty feet apart throughout the field, a week before the tobacco plants are set out.

"The balls should be moistened every two days or fresh ones substituted. The worms coming to the surface, finding no growing plants will eat the poisoned bait and be killed thereby. This remedy is applicable to all kinds of cut-worms, and has been found very satisfactory by those who have given it a trial."

THE BOLL-WORM (*Heliothis armigera*).—Sometimes attacks and severely damages tobacco. For remedies see page 154.

THE SNOWY-TREE CRICKET (*Œcanthus niveus*).—This insect never damages tobacco except when the field is infested by blackberry or raspberry bushes. (See page 98.)

Remedy.—Extirpate all blackberry or raspberry canes and give the crop thorough cultivation.

THE ARMY WORM.

(*Heliophila unipuncta.*)

The name is rather loosely applied to the larval stage of different insects of more or less pronounced migratory habits. The Tent Caterpillar, the Cotton-worm of the South, and the Southern Grass-worm, are, in different localities, all known as army worms.

The true army worm (*H. unipuncta*) belongs to the same order as the cut-worms; it is a native insect, the injuries of which were recorded in New England as long ago as 1743.

The worms feed by preference on grasses and small grains, showing a decided partiality for grass land on low wet soils.

The moth, though common, is scarcely known to farmers. It is

fawn-colored, with a white speck near the center of the front wings and with numerous black specks and a dark curved bar near the wing-tips. The abdomen and hind wings are of a dull gray color. The female lays her eggs at night between the folded sides of grass-blades, preferring to oviposit in matted tufts of coarse dead grass.

The eggs are glued to the grass with a white adhesive fluid which fastens them together and draws the sides of the grass-blades securely around them.

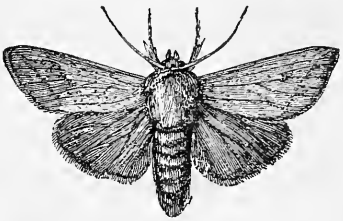


FIG. 136.—THE ARMY WORM. ADULT MOTH. NATURAL SIZE. (*Riley.*)

The eggs when fresh are glistening, white, opaque, and nearly spherical in shape.

The full-grown army worm measures about one and a half inches long, is of a dull gray color with black stripes, and narrow, interrupted lines of white along the back. The under side is greenish and the head pale yellow with brown lines on the sides and with a pair of curved stripes approaching each other near the mouth and diverging toward the back of the head.

FIG. 137.—THE ARMY WORM LARVA. NATURAL SIZE. (*Riley.*)

Professor Garman in treating of the life history of this insect says:

"The moths which have lurked about among grasses and refuse during the winter, come out of their hiding places as soon as grass starts in spring, and deposit their eggs in the tufts of blades and even in the dried stems. The eggs may be thrust beneath the ensheathing part of grass blades, but are often quite exposed. Grass which grows on low and damp ground appears to be preferred, and it is generally from neglected meadows in such land that the worms get a start. The moths fly chiefly at night and are often attracted at that time to any exposed sweets, such as syrups, or honey, for which they have a great fondness. The worms which hatch from the eggs laid by these females are soon among the grasses feeding much like cut-worms, but being active during the day as well as night. When not feeding they conceal themselves under clods and in the ground.

"Commonly this brood of worms does no perceptible harm, but occasionally when very abundant, the migrating instinct is developed and great armies of almost incredible numbers of worms from two-thirds grown upward, march along the ground devouring everything in the way of vegetation before them. They generally all march in one direction in the same field, and stop for no obstructions, even rushing into water, and creeping over one another in their eagerness to get forward. These armies appear about the time wheat is ripe, and are especially destructive to wheat, oats and corn, literally devouring the crop in some instances.

"When full-grown the worms stop feeding, enter the ground an inch or two, or conceal themselves under loose rubbish, where they moult their skins and change to the brown pupæ. In time the pupæ yield the winged moths which deposit eggs for another generation.

"The injury done is mainly the work of the spring brood. Several other broods develop during the summer, but the worms are scattered and live like cut-worms, never, so far as I know, marching in armies.

"The worms are almost omnivorous, but do not like clover, and feed by preference on grasses and small grains. The winter is passed both as worms and as moths."

Remedies.—The army worm is preyed upon by birds and by parasitic and predaceous insects, and is, also, decimated by bacterial forms of disease.

Burning over meadows or pastures in spring is probably the easiest and most practical method now known of dealing with the pest.

In the future, possibly the dissemination of the germs of contagious diseases to which the insect is subject will prove a formidable agency for their destruction. In the bulletin above referred to Professor Garman gives the following general remedial treatment for this insect :—

"It is unfortunately not possible to predict the appearance of the worms in destructive numbers any length of time beforehand, hence it is not possible to head them off by the use of fire in fields in which they will start. Burning over old meadows is however to be recommended as well worth practicing occasionally, as a means of guarding against the increase of this and of other grass-infesting insects also. If we could say positively when a destructive brood would appear we could by this means prevent most of the coming injury.

"After the worms appear and begin to march, it is the common practice to dig or plow trenches before them and about grain fields which are threatened with invasion. The worms accumulate in these trenches

and can then be destroyed by the use of kerosene or by mechanical means.

"Another practice often recommended as giving good results is the placing of fence boards in the ground, end to end, before the armies of worms and smearing the exposed edge of the boards with coal-tar mixed with grease.

"Where it is possible to use London purple or Paris green without danger to stock or to man, these poisons may be sprayed upon the vegetation before the advancing worms, and should prove a complete check. Where it is a matter of saving a crop of wheat or oats this method is to be recommended even if it involves sending the stock to other pastures for a time."

WIRE-WORMS OR DRILL-WORMS.

Wire-worms or drill-worms properly belong to the larvæ of several species of clicking or snapping beetles (*Elator*), so called from the facility with which the beetles, when laid upon their backs, spring into the air with a resonant, clicking noise, landing, in most cases, on

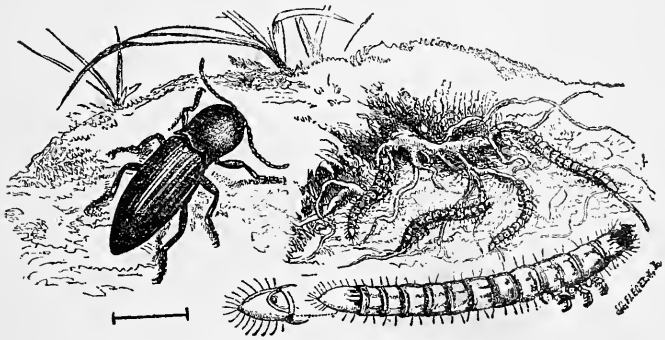


FIG. 138.—SNAPPING-BEETLE OR WIRE-WORM, WITH LARVÆ.

their feet. The winged beetles live upon rotten wood, and hence a valid reason why decaying posts and fence rails be removed from the corn-field to the wood-pile.

The larvæ are slender wire-like worms, varying in color from white to yellow, resembling bits of light wire. The larval stage lasts for two, three, and some entomologists say, five years ; it is, therefore, no small task to free land once badly infested with these insects. The

worms do great damage to potatoes, cereal grains and the grasses, and will even bore into seed Indian corn, often destroying it in the ground before germination.

Professor Garman (Bulletin No. 40, Kentucky Experiment Station) says. "Normally the larvæ appear to live in grass land, where the harm they do is not apparent. If this is plowed up and planted in corn or potatoes the worms, deprived of their accustomed food, turn to the crop and often are exceedingly troublesome, in some cases compelling farmers to replant several times.

FIG. 139.—ADULT OF WIRE-WORM.

"The worms are white or yellow, cylindrical, and are rather hard-bodied for larvæ. Each has three pairs of jointed legs just behind the head, and no more. This feature of their structure will always serve to distinguish them from the cylindrical thousand legs, or millipedes, which are sometimes also called wire-worms."

Remedies.—An English practice is to sow along with the seed bits of rape-cake soaked in arsenic. Poisoned corn harrowed in shortly before planting the regular crop would probably answer the same purpose. Autumn and early spring plowing with frequent harrowing expose the worms to birds which are our ever constant but little appreciated allies in combating formidable insect pests.

Professor Garman in the bulletin above quoted says:

"In fields recently in sod it is not possible to avoid all injury from wire-worms, but the planter may avoid some loss perhaps by putting such land in the crops least subject to injury, such as hemp, tobacco, or wheat, until the worms have disappeared. A fact of considerable importance in this connection has recently been made out by Professor J. H. Comstock, of New York. He found by experiment that the wire-worm pupæ die when the earthen cells in which they lie are broken. This fact has suggested the expedient of ploughing up infested land in the fall of the year so as to expose and destroy the pupæ.

FIG. 140.—WIRE-WORM.

"A method sometimes practiced in gardens, is to thrust sticks through pieces of potatoes and then bury these here and there in the ground which it is intended to plant, leaving part of each stick exposed to find them by. The bait is then taken up at intervals and the worms which have been attracted to it are destroyed.

"The method has of course no great value as a means of ridding large fields of wire-worms, but it is said to be quite effective for the small plots of gardeners."

TOBACCO.

THE TOBACCO WORM.

(*Phlegethontius carolina*).

Two species occur in the United States, both of which feed on the same plants and are much alike in appearance, habits, and life history. This species is of southern distribution and may be readily distin-

FIG. 141.—THE ADULT OF THE TOBACCO WORM. NATURAL SIZE. (*Garman.*)

guished from its northern relative, the Potato or Tomato worm (*P. celeus*) by darker colors and by the presence of small white spots near the base of the fore-wings.

There are two annual broods; the first is the chief pest of the southern tobacco fields, feeding almost exclusively on tobacco; the second brood feeds chiefly on the leaves of the tomato until frost, when the worms retire to the earth until spring. The pupa is bright brown, nearly cylindrical in form and is provided with a long tongue case, resembling a jug or pitcher handle.

Remedies.—Hand-picking the worms, though tedious, is resorted to in many parts of the south. The adult moths are destroyed by intro-

ducing into the flowers of the Jamestown weed (*Datura stramonium*), a little liquid cobalt, or sweetened whisky and water poisoned with arsenic. Many planters purposely plant the Jamestown or "Jimpson" weed for this purpose in their tobacco fields. The late brood of tobacco worms confines its depredations almost altogether to the tomato. Late fall plowing kills many of the pupæ; the larvæ are also destroyed by the microgaster parasite, like the Potato or Tomato worm.

FIG. 142.—PUPA OF THE TOBACCO WORM. NATURAL SIZE. (*Garman.*)

THE FLEA-BEETLE, OR TOBACCO FLY.

(*Crepidodera cucumeris.*)

A little beetle that attacks the tender plants in the seed-bed. This insect lives through the winter in the winged state, hidden away under leaves, rubbish, etc. It also attacks the tomato and potato.

Remedies.—Professor Gerald McCarthy gives the following (North Carolina Experiment Station, Bulletin No. 78):—"Sprinkling the plants with powdered lime moistened with turpentine, or dusting with soot, wood-ashes, or road dust instead of lime. A hot (125° F.) decoction of tobacco stems will kill all the flies it touches. The best remedy is, however, covering the seed beds with netting, or with the prepared cloth sold for that purpose."

FIG. 143.—FLEA-BEETLE. MAGNIFIED. (*Riley.*)

COTTON.

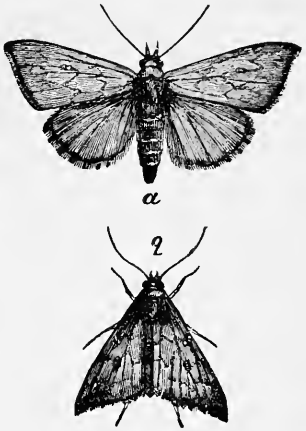
THE COTTON CATERPILLAR.

(*Aletia xylina.*)

This insect has been exhaustively treated by Dr. Riley in Bulletin No. 3 of the United States Entomological Commission. The adult is a grayish-brown, night-flying moth, a native of sub-tropical America, from whence it migrates northward during summer as far as the 35th parallel.

The females lay from 150 to 400 eggs, which are greenish at first, but soon change to a dull whitish color.

The eggs are deposited singly on the under side of the cotton leaves. They hatch in from two to three days and the young caterpillars at once begin to feed upon the leaves. The caterpillar stage is completed in about twenty days, and the quiescent pupal period follows, lasting for ten days, when the mature moths come forth. In the more northern cotton States there are about three broods each season, while in the States bordering on the Gulf of Mexico there are from five to six broods. The moths feed upon the juices of fruits and the nectar of flowers.



COTTON MOTH.
a. With wings expanded. *b*. With wings closed.

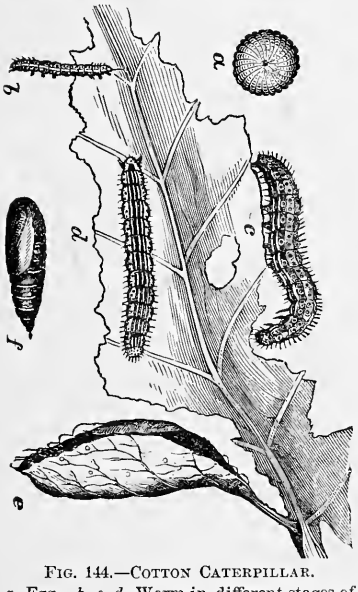


FIG. 144.—COTTON CATERPILLAR.
a. Egg. *b*, *c*, *d*. Worm in different stages of growth. *e*. Pupa rolled in leaf. *f*. Pupa removed from leaf. (*Riley*.)

Remedies.—Paris green and London purple are very generally used for destroying the caterpillars, or "worms" as they are almost universally called. A practice in several of the southern states is to attach a bag containing Paris green to each end of a pole about eight feet long, and to balance the pole on the pommel of the saddle while the rider passes slowly through the rows, dusting the poison over the plants at each step of the horse or mule. One man and a mule, it is said, can treat 40 acres per day by this method, and about one pound of poison is sufficient for an acre. The animal should be well washed after

the day's labor, to remove the particles of poison which adhere to its coat.

Professor J. P. Campbell, Entomologist, Georgia Experiment Station (Bulletin No. 6, January, 1890) gives the following :—"One pound of Paris green is thoroughly mixed with twenty pounds of flour and ten pounds of cotton-seed meal, this mixture being applied to one acre. This may be simply done by using a piece of burlap cloth large enough to hold about a half-peck of the mixture. The edges are gathered together and held in the hand. This is then shaken over the cotton and a very thorough distribution is secured."

In windy weather the dry application of poison by this method is impracticable.

The best way to use the arsenites for the cotton caterpillar is in suspension with water, and by means of a force-pump and spraying nozzle. Use one pound of the poison to from 200 to 250 gallons of water. For the use of pyrethro-kerosene emulsion on the cotton caterpillar, see page 46.

The moths are strongly attracted by a mixture of molasses and water, to which a little whisky or other spirits is added.

A minute quantity of Paris green or white arsenic may be added to this liquid, and if it is then set in shallow dishes through the cotton field, large numbers of the moths will be killed.

The monitor moth-trap, see page 36, will probably prove effective in destroying large numbers of the moths. The suggestion of Professor Shaler for trapping the male Gypsy moths by exposing the females in traps is well worthy of experiment with the cotton moth. See page 36.

CEREAL GRAINS.

THE HESSIAN FLY.

(*Cecidomyia destructor.*)

The Hessian Fly is a small two-winged gnat, much like the mosquito in shape and size. The adult insect has a dark-brown body and dull, smoky, brown wings, and though much smaller, somewhat resembles the common house-fly.

Two broods are developed each year, the first hatching from the eggs of the flies which have passed the winter as "*flax-seeds*,"—a name given to the pupa,—emerging as flies early in the spring, and their eggs are deposited on the young wheat during April and May. The grubs hatching from these eggs become "*flax-seeds*" as harvest approaches

and many remain in this stage in the stubble after the crop has been cut. The flies from this brood emerge in time to deposit their eggs on the fall wheat for the second brood, which hatches in about four days after the eggs have been laid in the leaves of the young winter wheat. The grubs make their way down to the sheathing and crowd themselves between the blades and stems, where they form cavities in the stems by the continued pressure of their bodies. The change from grub to "flax-seed" follows and in this stage the insect passes the winter.

Remedies.—Professor Garman (Kentucky Experiment Station, Bulletin 40), suggests the following remedial treatment, and says:

"The practice of planting fall wheat late has every consideration in

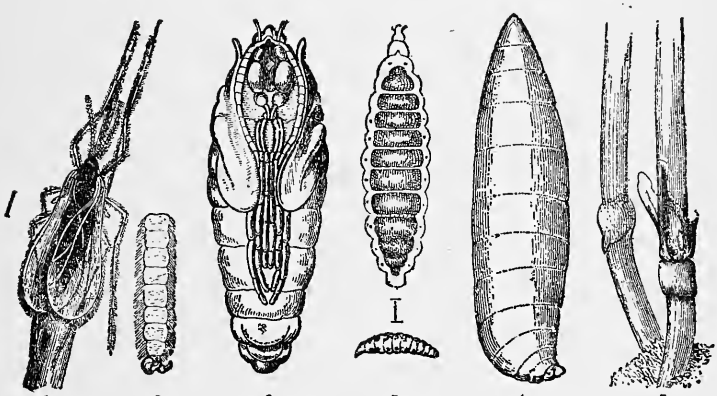


FIG. 145.—HESSIAN FLY.

1. Adult female. 2. Male abdomen. 3. Pupa removed from "Flax-seed." 4, 5. Larva. 7. "Flax-seed" in position.

its favor as a means of avoiding the flies. At this latitude especially, where the falls are long and winters mild, it is not open to the objection sometimes offered farther north, that the injury by frost to late-sown wheat counterbalances all the good which comes from lessened injury from the flies. It has now become the almost invariable resort of growers of small grain in all parts of the United States.

"On the other hand it must be admitted that good practical farmers have sometimes insisted that the contrary practice of sowing wheat very early was the better of the two. Looking at the matter from the standpoint of a full knowledge of the life history of the insect, it

would seem that the common practice of late sowing was much the more likely to accomplish the desired result.

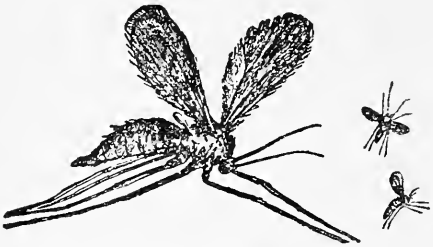


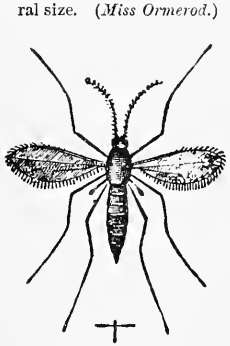
FIG. 146.—ADULT HESSIAN FLY.
Small figures natural size. (*Miss Ormerod.*)

"In connection with late planting two other procedures should be followed during outbreaks.

"The first is that of burning over stubble fields as soon as possible after the wheat is cut, for the purpose of destroying all flax-seeds which remain in the stems. I know that an eminent entomologist has questioned the advantage to be gained in destroying the flax seeds in stubble, urging against it the fact that at the same time, many of the parasites of the fly would be destroyed. Most farmers will, I am sure, not be deterred by any such considerations. We can well dispense with parasites if we can get rid of the insects they harbor.

FLAX-SEED OF HESSIAN FLY.
Small figures indicate natural size. (*Miss Ormerod.*)

"The second practice to be recommended is the planting of small plots of very early wheat as lures to the flies, so as to entice them into depositing their eggs before the regular crop comes up. The wheat of the plots can then be destroyed by deep plowing, or otherwise.



ADULT HESSIAN FLY.
(*Miss Ormerod.*)

"These practices have the sanction of the most recent and thorough study of Hessian fly injury. It is believed that when farmers generally practice late planting, with judgment, and supplement it by the precautions just mentioned, severe injury from Hessian fly need not be greatly feared.

"With the above, a few other methods of lessening injury may be mentioned as having had advocates among practical farmers. (1) The use of air-slaked or water-slaked lime

sowed broadcast over growing wheat, at the rate of one or two bushels per acre, has been strongly advocated. (2) Close grazing by sheep has also been declared beneficial, the sheep being thought to destroy the grubs and flax-seeds. (3) The selection of 'fly-proof' varieties of grain, the Mediterranean wheat and red wheats being claimed to be most nearly exempt from attack. The testimony on this head is, however, very conflicting, and no recommendations can be safely based on it. (4) The use of fertilizers here, as in other cases of insect attack, is to be recommended strongly, as calculated to stimulate the growth of infested wheat until it is beyond danger."

Professor Gerald McCarthy (Bulletin No. 78, North Carolina Experiment Station), expresses the following views :—

"In cutting the grain the sickle-bar should be set as high as possible, so as to avoid carrying off the insects. As soon as the grain is got out of the way the stubble should be burnt over, thus destroying at a blow all the contained pests. If the ground is then plowed and sown in cow-peas, so much the better for the land. The dust removed by the blower of the thresher usually contains most of the pupæ carried off in the harvest, and this dust should also be burnt. To be wholly efficacious the burning of the stubble must be carried out by an entire neighborhood, as a single neglected field will produce flies enough to infect a whole township. As this insect is very delicate in the winged state, if the sowing of fall grain is delayed until after the first severe frost there will be little damage from the fall brood. Another precaution is to sow early in the fall around the field where it is proposed to sow a small grain-crop, a narrow strip of some rapid-growing soft wheat, such as Diehl. This will serve as a trap to receive the eggs of the flies. When the flies have ceased to work in it, this strip should be plowed under as deeply as possible, and the ground rolled firm. The main crop may be then sown in safety. The red and yellow wheats have harder stalks than the white varieties, and are, therefore, less troubled by the Hessian Fly. This fact is worth remembering in localities where the fly is abundant."

CHINCH-BUG.

(*Blissas leucopteris.*)

When full grown the chinch-bug is about one-seventh of an inch long, black with white upper wings, having two well defined black spots on them as seen in Fig. 147.

The young bugs vary from pale yellow to a bright red, and the pupa is reddish-brown and wingless. The mature insect hibernates through

the winter, hidden away within the leaf sheaths of corn stalks in the shocks of corn, crevices of fences or under the shelter of all sorts of rubbish affording protection from rain. This insect is not affected by cold but quickly succumbs to moisture.

FIG. 147.—CHINCH-BUG. ADULT.

The chinch-bug is two-brooded in the middle states and is believed to be three-brooded in the extreme southern states. The female deposits her eggs near or under ground, upon the stems and roots of wheat, corn, oats and grasses and the young remain in or near the earth sucking the sap from the stems and roots.

Remedies.—The disgusting bed-bug-like odor of both the young and adult insect appears to protect them from most insect-eating birds and predaceous insects. They are, however, eaten to some extent by quail and possibly by other birds: among insects, the lady-bird beetle possibly destroys them in considerable numbers. The chinch bug is subject to the attacks of bacterial diseases, which are the most potent factors in reducing their numbers. All rubbish accumulations along fences and head-lands should be hauled into the field and burned. Autumn plowing and heavy rolling the land for spring grain perceptibly decreases the damages of the pest. Spraying with kerosene emulsion kills the bugs without injury to the crop.

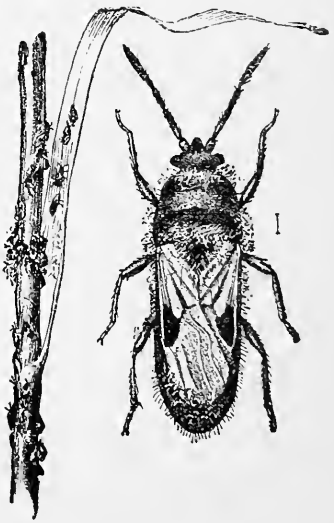


FIG. 148. CHINCH-BUGS AFFECTED BY ENTOMOPHTHORA. (*Lugger.*)

This insect sometimes appears in armies, moving in solid columns from field to field, devouring wheat, corn, or barley. Such migrations are stayed by laying a thin layer of coal tar across the path of the pest. Between the tar-line and the bugs deep holes are dug, into which many of the bugs will fall or may be swept and buried.

Undoubtedly, the best remedies are those that kill the bugs and at once put an end to their depredations. With good spraying machines, kerosene emulsion is probably the best practicable remedy in the hands of the farmer. Infested grass and grain lands should be burned over during fall and winter and all rubbish destroyed that offers shelter to this insect. In the future, serious devastation by the chinch-bug will probably be prevented by propagating the bacterial forms of disease to which the pest readily succumbs.

THE WHEAT-HEAD ARMY WORM.

(*Laucania cecidomyia.*)

This insect closely resembles the true army worm, from which it differs in appearance when young in having the head black. The young worm feeds upon grasses, leaves, etc., and when half grown, shows decided preference for such food as the heads of wheat and other cereal grains. It was first observed in Pennsylvania, then in Delaware and Maryland, and later in several of the great wheat producing states of the west. Dr. Riley in his celebrated reports as State Entomologist of Missouri, records the presence of the insect in that state, and it has also been observed on the wheat ranges of Kansas and Nebraska.

Remedies.—The pest is held in check by several parasitic enemies. The moth may be destroyed by the use of lantern traps near which vessels containing poisoned sweet liquids have been placed. White arsenic, London purple, or Paris green in minute quantities may be used for this purpose.

THE WHEAT MIDGE.

(*Cecidomyia tritici.*)

In the adult stage this insect much resembles the Hessian fly and was formerly regarded by entomologists as belonging to the same genus. The eggs are laid in the flowers of the wheat, and soon

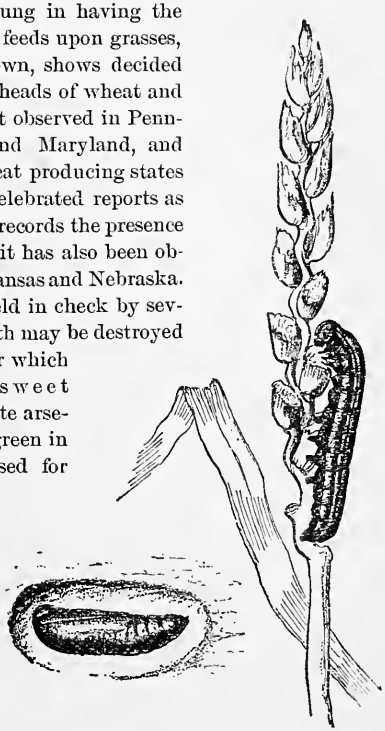


FIG. 149.—ARMY-WORM, LARVA EATING EAR OF WHEAT, AND PUPA.

numerous orange-colored maggots, known as midges, are found in the forming grain, which becomes shriveled and worthless.

Remedies.—Burn all the refuse after cleaning infested grain. As many of the larvæ pupate in the ground, deep plowing is believed to aid materially in reducing their numbers, by turning them so deeply into the earth that the insects are unable to regain the surface. The wheat midge has some parasitic foes which help to hold it in check.

THE WHEAT-BULB WORM.

(*Meromyza americana.*)

This insect is the larva of a two-winged fly which lays her eggs on the young wheat in autumn. The larvæ feed upon the central portion of the stem just above ground, becoming full-grown in spring when they pupate, and emerge as flies about a fortnight later. A brood of larvæ from these early flies complete their transformations in July

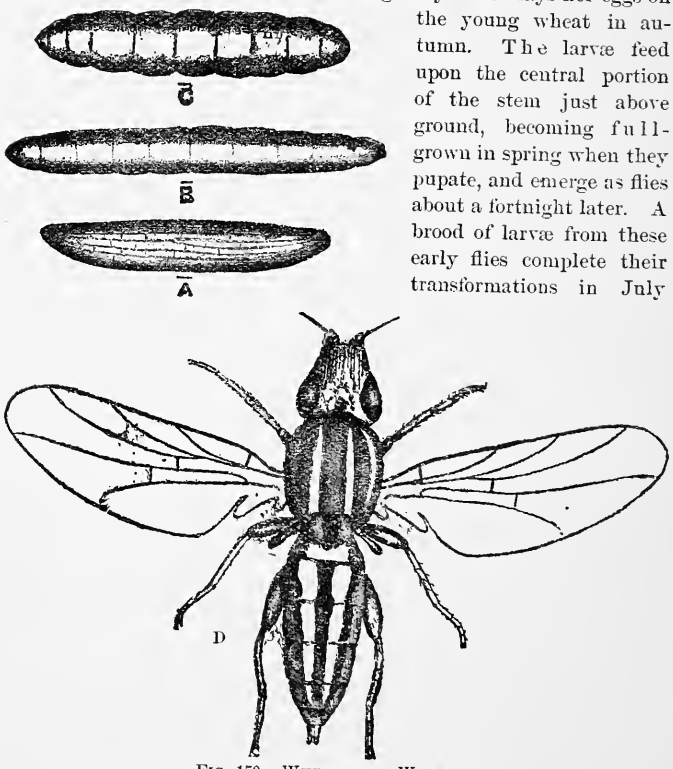


FIG. 150.—WHEAT-BULB WORM.
A. Egg. B. Larva. C. Puparium. D. Fly. Magnified. (*Garman.*)

and deposit their eggs on volunteer wheat from which another brood comes forth in time to lay their eggs on fall wheat. This insect also affects oats and other grains.

Remedies.—No very efficient means are known for combating this insect. All volunteer wheat should be destroyed after the worms begin to appear.

THE GRAIN LOUSE.

(*Siphonophora avenæ.*)

A small plant louse belonging to the group of insects, nearly all of which take food in the liquid form, some deriving it from animals and others from plants. Plant lice live exclusively on living plants, which they injure chiefly by appropriating to their own use the sap which, otherwise, would be used by the plant in normal growth, the production of wood, leaves, flowers, and seed.

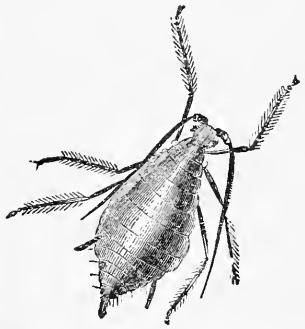


Fig. 151.—The Wingless Form of the Grain Louse, Enlarged (*Garman.*)

Professor Garman (Kentucky Experiment Station, Bulletin No. 40) says of this pest :—

"A peculiarity of this insect is worth mentioning here, since it explains its sudden appearance in great numbers. Unlike the chinch-bug and Hessian fly it does not develop in broods at tolerably constant times of the year, but the individuals are all females, and all, as soon as adult, begin to produce living young after the manner of the higher animals (mammals) and continue doing so all the rest of their lives. No male or egg-laying female of the grain louse has ever been seen. It has been estimated by Huxley that the tenth generation alone of one of these insects, 'if all the members survived the perils to which they are exposed, contains more ponderable substance than five hundred millions of stout men, that is, more than the whole population of China.'

"This calculation serves only to give an idea of the possibilities and advantages of this method of reproduction ; for the insects are so helpless, and are subject to so many accidents and enemies that there is never anything like an approach to a realization of the possibility in nature."

Remedies.—From experiments at the Kentucky Experiment Station in 1890 it seems possible to keep this pest under control on young wheat or oats by spraying the crop with a strong decoction of tobacco stems or by the use of kerosene emulsion and water. Use with spraying apparatus and at the rate of about 100 gallons to the acre.

"It became apparent in the winter of 1889," says Professor Garman, "from reports of correspondents, that much of the greatest damage was done to wheat which had been planted on oats land. My own observations on the insect were made largely at Lexington, where I found a similar condition of things. This is just what we should expect from the habits of the insect. When wheat is ripe in spring the grain lice leave it for oats, and when this ripens in turn, they resort to neighboring corn or blue grass, and come back to the grain fields when volunteer oats spring up. On this they breed until fall, when, if the land is sown to wheat, they are ready for it. They seem specially fond of these volunteer plants and may be found on them until they are destroyed by frost. The effect of planting on or near old oats land was well shown in the spring of 1890 on the Experiment farm, where one of a series of wheat plots which was next land that had been in oats, was seriously endangered by a migration of lice to it from volunteer oats. At the same time the other plants farther away contained very few grain lice.

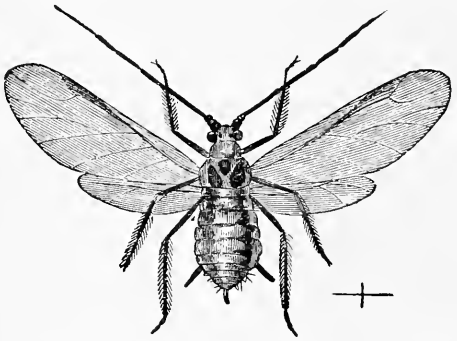


FIG. 152.—THE WINGED FORM OF THE GRAIN LOUSE, ENLARGED. (*Garman.*)

"The conclusions to be drawn from these facts is that during outbreaks of the grain louse, oats land should be avoided in planting fall wheat, and all volunteer oats should be carefully destroyed."

The same writer recommends for trial freshly slaked lime with a little carbolic acid added, to be sown broadcast on infested wheat or oats.

CRANE-FLIES.

CRANE FLIES are also known as Gallinippers and cut-worm flies. The eggs are deposited in low, damp grain, grass or clover land, and the larvæ feed upon the roots, occasionally appearing above the surface in damp, wet weather.

Remedies.—For clover or grass fields no remedy is yet known.

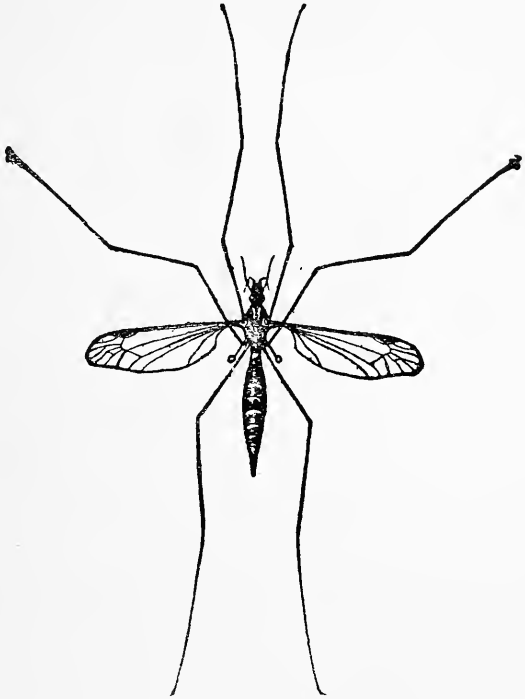


FIG. 153.—THICK-NOSED CRANE-FLY (*Pachyrrhina Sp.*). ADULT FEMALE.

In wheat lands the injuries of the pest may be prevented by plowing early in autumn. The insects of this family, of which several species are known to be destructive to grains and grasses, are believed to have many natural enemies both among birds and insects.

THE CLOVER-ROOT BORER.

(*Hylastes trifolii.*)

This is a foreign species introduced from Europe about fifteen years ago. The adult is a small brownish-black beetle that early in spring deposits small whitish, elliptical eggs within the crowns of the clover plant.

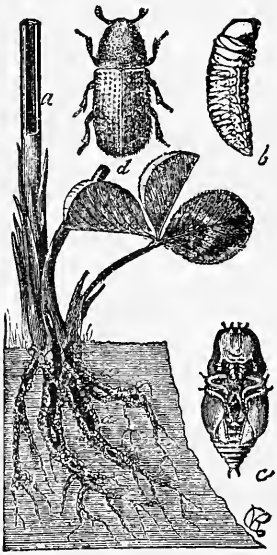


FIG. 154.—CLOVER-ROOT BORER.

a. Infested plant. *b*. Larva. *c*. Pupa. *d*. Beetle. *b*, *c*, *d*. Magnified. (*Riley*.)

From four to six eggs are laid in each crown and the eggs soon hatch into small whitish worms. When full-grown the grub has a whitish body and yellow head, and is about one-eighth of an inch long.

The grubs burrow downward, tunneling the branches of the roots and filling the cavities thus formed with brownish castings.

The larval stage is completed late in summer, and the insects pupate in burrows made in the roots, soon afterward emerging as beetles.

Remedies.—The injuries done by this insect have been confined to a few States in the east, but its ravages are extending, and unless checked, the pest will become common throughout the country. It is during the second year that the root-borer works greatest injury in the clover fields, and it is only by more frequent crop rotations that the increase of the pest is to be checked.

The second year's growth should be mowed over but once, and the second growth plowed under or pastured.

THE CLOVER-LEAF BEETLE.

(*Phytonomus punctatus.*)

This is another European species known in this country for the past quarter of a century. The adult is a dark brownish snout-beetle, a little less than half an inch long; it deposits its eggs in clusters on the leaves or flower-stems near the base of the plant. According

to Dr. Riley both the larvæ and adult insects feed upon the clover leaves at night, concealing themselves under the leaves and the dead grass and rubbish of the soil during the day. Each female deposits from 200 to 300 eggs which hatch in about ten days into legless grubs that at once begin to devour the leaves. The larvæ complete their growth in from 7 to 8 weeks and then form pale yellowish *netted*

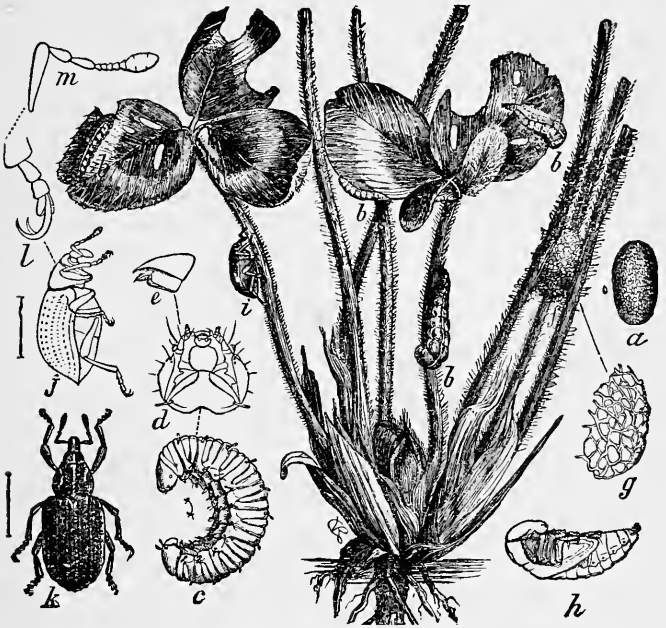


FIG. 155.—CLOVER-LEAF BEETLE.

b, b, b, b. Larva feeding. *f.* Cocoon. *i.* Beetle; all natural size. *a.* Egg. *c.* Young larva. *g.* Meshes of cocoon. *h.* Pupa. *k, j.* Beetle, back and side views. Magnified. (*Riley.*)

cocoons just below the surface of the soil. A month later the beetles emerge.

Remedies.—No remedy has yet been suggested for this insect. Infested fields should be plowed under in May or June, by which means developing larvæ may be destroyed.

THE CLOVER-SEED MIDGE.

(*Cecidomyia leguminicola.*)

The larvæ is a small, bright, orange-colored maggot, that lives within the clover-heads, feeding upon their substance, and causing the plants to produce shriveled, worthless seed. The parent is a small, two-winged fly, somewhat similar in appearance to the Hessian Fly. The eggs are deposited by the female among the flowers, by means of a long ovipositor provided for that purpose. When fully developed the larvæ find their way to the ground and pupate in slight cocoons among dead grasses, or just below the surface. The flies emerge about a

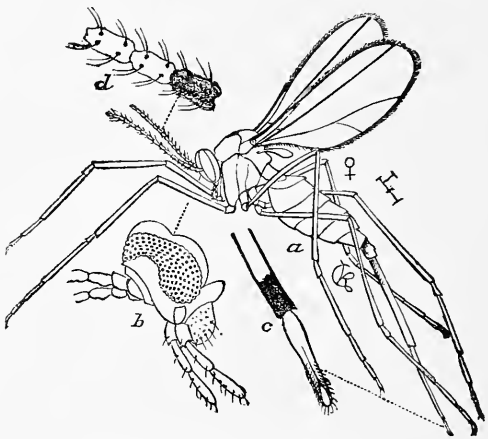


FIG. 156.—CLOVER-SEED MIDGE.
a. Fly. *b*. Larva. Magnified. (*Riley.*)

fortnight later. In the northern states there are two broods each season; in the southern states there are *three* broods *and possibly* four.

Remedies.—Professor Clarence M. Weed, in his work, "Insects and Insecticides," page 238, states:—

"The best preventive of the injuries of this insect yet suggested, is that of mowing the field about the middle of May (in the latitude of central Ohio) when the green heads are just forming, and leaving the partial crop, thus cut, on the ground as a mulch and fertilizer. A new crop of blossoms is produced, which comes between the regular crop, and also between the two broods of the midge. This method has been tried for several years by some of the best farmers of Ohio, with excellent results."

THE CLOVER-STEM BORER.

(*Languria mozardia.*)

The adult is a pretty moth, purplish or reddish-brown in color, with golden-yellow markings on the wings. The eggs are deposited in the clover hay, soon hatching into small, brown worms, which web the leaves and stems together with multitudes of silken threads, feeding upon the substance of the hay, and unfitting it for the food of stock.

This species is also of European origin ; two broods occur each season.

Remedies.—The old hay from previous seasons should all be removed before introducing new hay into the mow, which should be carefully cleaned. Hay that is badly infested with worms should be burned.

THE CLOVER HAY-WORM.

(*Asopia costalis.*)

The adult is a small golden and purplish moth, which deposits her eggs in clover hay. The eggs soon hatch into small brown worms which feed upon the leaves and stems and then web them together with silken threads. Two, and possibly more broods, appear each season.

Remedies.—When hay becomes badly infested, it should be promptly burned. Before storing new hay the mows should be well cleaned each season, and stacks should not be erected on old foundations until all the hay and refuse of a previous year have been removed.

LOCUSTS OR GRASSHOPPERS.

(*Acrididæ.*)

Of the many species comprising the locust family we shall pause only to consider three species of very considerable geographical distribution. These are the ROCKY MOUNTAIN LOCUST or WESTERN GRASSHOPPER (*Melanoplus spretus*), the BIRD GRASSHOPPER or AMERICAN LOCUST (*Acridium americanum*), and the RED-LEGGED LOCUST (*Melanoplus femur-rubrum*).

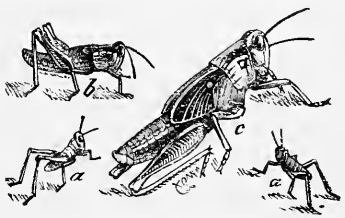


FIG. 157.—ROCKY MOUNTAIN LOCUST. *a, b.* Young nymphs. *c.* Fully developed nymph or pupa. (*Riley.*)

THE ROCKY MOUNTAIN LOCUST, WESTERN GRASSHOPPER, or "HATEFUL GRASSHOPPER," as it is sometimes called in the west, is the most destructive species of the family.

The native home of this insect is the high table-lands and hot sandy plains of the Rocky Mountain region.

From these elevated levels, comparatively destitute of vegetation, the pest swarms forth over nearly one-third of the United States, crossing the snowy ranges, 15,000 feet above sea-level, and migrating eastward to the Mississippi valley.

The insects, however, are unable to breed permanently in the lower and more humid levels, and the progeny of the migratory hordes soon perish.

It is only upon the parched plains, from five to six thousand feet above the level of the sea, where the rays of the summer's sun beat down upon a desert almost destitute of life, and where the air is like that of a furnace, that the Rocky Mountain locust finds its most favorable conditions of life.

FIG. 158.—ROCKY MOUNTAIN LOCUST. ADULT. (*Riley.*)

When from a scarcity of food the pest leaves its natural habitat and invades another locality, the females at once begin laying eggs, which are deposited in cylindrical holes in the ground. In a humid climate the females choose exposed and elevated locations where vegetation is scanty and where the soil is rather firm. Each female lays from two to three batches of eggs, each batch containing from twenty to thirty eggs which are deposited in bean-shaped masses in the ground. The time required from hatching to full development averages about two months, but varies with the warmth and dryness of the season.

THE BIRD GRASSHOPPER OR AMERICAN LOCUST (*Acridium americanum*), and the RED LEGGED LOCUST (*Melanoplus femur-rubrum*). The former is a native of the southern states but is common as far

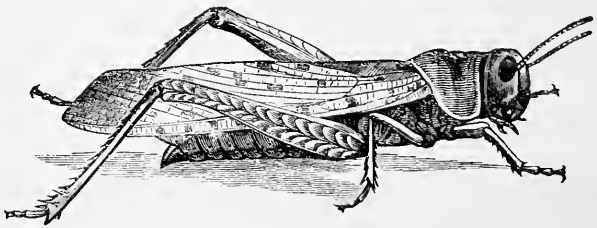


FIG. 159.—BIRD GRASSHOPPER OR AMERICAN LOCUST. (*Riley.*)

north as southern Pennsylvania and central Ohio and in the same latitude further west. It is a handsome insect, and when flying may be easily mistaken for a small bird.

The *Red-legged* locust is similar to and closely related to the Rocky Mountain locust, but is less destructive, and the depredations of the former never cause the widespread losses of the Rocky Mountain locust.

FIG. 160.—THE RED-LEGGED LOCUST. (*After Riley.*)

The female deposits her eggs in September, in cylindrical holes in the earth. "The food habits of these locusts," says Professor S. A. Forbes, "are extremely simple, and consist in eating nearly everything that comes in their way. They are quiet at night, and indeed, as they mature, they select elevated positions as roosts, climbing to the tops of stems of grass in meadows, to the tassels of the stalks in cornfields, and even deserting fields of low herbage if they can find more elevated roosting points near by. When very abundant, and when

FIG. 161.—FIELD-CRICKETS.
1 and 2. Adults. 4. Active pupa. Below 1 Crickets just hatched.

the weather continues dry, they occasionally swarm like the Rocky Mountain Locust, but rarely flying continuously to any great distance, or indeed taking any definite course."

Locusts are usually of a dull, dingy color, resembling the ground upon which their lives are mostly spent. Katydids, Sword-bearers, and Cone-heads which, however, belong among the jumping Orthoptera,

are mostly bright green, and their lives for the most part are spent among woods and trees. The eggs of these latter insects are usually glued to twigs, or inserted into the pith of plants. Tree-crickets, Field-crickets, and Mole-crickets also belong in the order of the Orthoptera. All crickets are more or less injurious to plants, but they destroy large numbers of more injurious insects.

These insects produce their love-songs by grating together the bases of the upper wings, which are modified for this purpose. The sounds are made only by the males to attract the females.

Remedies.—Man is powerless before the cloud-like hosts of locusts that at times desolate whole communities. Fortunately these visitations are becoming rarer, and, with a better knowledge of the habits

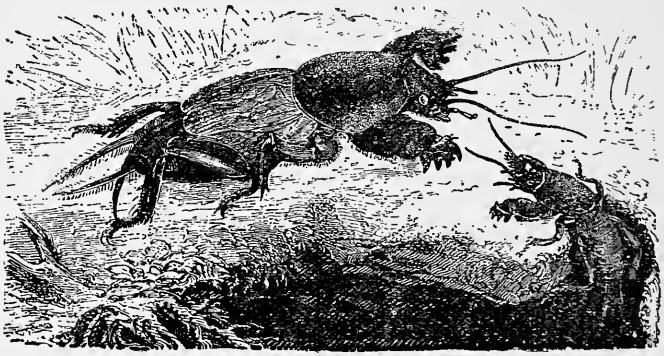


FIG. 162.—MOLE-CRICKET.

and life history of the migrating species, the people of the west will be better able to meet and repulse invasions.

The most opportune time for fighting locusts is when they are either in the egg or larval stages. Much may then be done by harrowing or shallow plowing lands known to be the breeding grounds of the pest. Thousands of the egg cases are thus broken up and exposed to the action of the weather and the natural enemies of the insect. The methods by which the young may be destroyed have been classified by the United States Entomological Commission as follows :—(1) BURNING ; (2) CRUSHING ; (3) TRAPPING ; (4) CATCHING ; (5) USE OF DESTRUCTIVE AGENTS.

By the first method old straw, hay or rakings may be scattered "over and around the field in heaps and windrows, into which the

locusts for some time after they hatch may be driven and burned." During cold or damp weather the locusts will seek shelter under the straw or hay and in their benumbed condition may be burned along with the litter.

The second method, crushing, is most successful on upland fields that are smooth or hard. Dr. Riley says, "When the surface of the ground presents this character, heavy rolling can be successfully employed, especially in the mornings and evenings of the first eight or ten days after the newly hatched young have made their appearance, as they are generally sluggish during these times, and huddle together until after sunrise."

Trapping and catching, the third and fourth methods proposed, include ditching and trenching, and the use of "*hopper dozers*," or pans covered with coal tar or kerosene. Ditches about two feet wide and of the same depth, with perpendicular sides, are dug, into which the

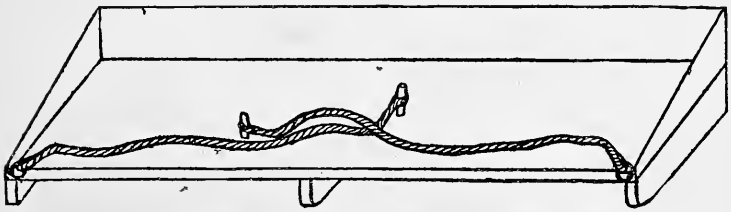


FIG. 163.—HOPPER DOZER, FOR CATCHING LOCUSTS AND SIMILAR INSECTS. (*Smith.*)

young locusts are driven, where they soon die of starvation, or may be killed by mechanical means. The use of the hopper dozer, such as is seen in Fig. 163, is probably the simplest and most practical implement of destruction included under this heading.

"It is made of light sheet iron, ten to fifteen feet long by about three feet wide. The front should roll up half an inch or an inch to give a smooth face, while the back should be from six inches to a foot deep with side pieces to correspond. The inside of the pan should then be coated nearly half an inch deep with coal tar, and with a rope attached on either side the dozer is ready for use. Two persons can easily run such a pan, but horses may readily be attached to a larger one. The principle is all that is necessary to suggest and then each one can arrange details to suit the occasion. Whatever is used to draw the hopper dozer should be at either end, else the locusts would be driven each side before the tarred pan reached them. Of course at the ap-

proach of the machine the locusts leap and usually alight on the tar. The winged ones may fly entirely over, and often a stiff wire or stick placed a few inches in front of the dozer will help, as the plants will be stirred and start the locusts up sooner and drop them where desired. If very numerous, the insects will soon cover the tar, so that an occasional new supply will be needed. It is best of course to use the hopper dozer on the locusts as soon as they are noticed in numbers. At this time they will not be full fledged and can be caught easier. If they are mostly winged ones, fewer would escape if taken in the cooler parts of the day when they are not so active and are more apt to hop than fly. By going over the badly affected fields in this way several times at short intervals, a great deal is saved at slight expense."* (Michigan Agricultural Experiment Station, Bulletin 98.)

The use of destructive agents, such as poisons, has in the past been limited to small areas, but wherever bran can be had cheaply the free use of a mixture made thus is advisable :—

Bran, ...	100 pounds
Paris green, ...	3 "
Old molasses, ...	2 quarts.

Mix, adding a little water if necessary to make the mass cohere.

In Colorado this mixture is strewn between the rows of potatoes, corn, or through the alfalfa fields, and is devoured by the hoppers in preference to all other food. (See "Insect Life," Vol. VI, No. 1, November, 1893). This insecticide may be used on all cultivated lands or in grain fields, but must not be used in pastures or where there is a possibility of the poison being eaten by stock.

INSECTS INJURIOUS TO STORED GRAIN.

THE GRAIN WEEVIL.

(*Calandra granaria.*)

Also known as the Granary weevil and the Black weevil. This species is a black, dark reddish or brownish snout-beetle which deposits its eggs singly upon grain. The larvæ feed upon the substance of such grains as barley, corn, wheat, oats, etc.

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* Ten cents per acre is the estimated cost by the Iowa Experiment Station when all the help is hired. Experiments at Grand Junction, Colorado, in July, 1893, seem to indicate that crude petroleum oil is the best material for use in the hopper dozer. (See "Insect Life," Vol. VI, No. 1, November, 1893.)

Remedies.—Carbon Bisulphide is the best practical remedy for destroying this pest. Dr. Riley gives the following directions for its use.—"A ball of tow is tied to a stick of such length that it can reach the middle of the vessel containing the grain. The tow receives the charge of bisulphide like a sponge, and is at once plunged into the vessel.

"When necessary the stick may be withdrawn and the charge (of 1 ounce to 100 pounds of grain) may be removed. The action of carbon bisulphide lasts, in ordinary cases, six weeks, after which period a fresh charge is required. The bisulphide does no harm to the grain as regards its color, smell, or cooking properties, and the germinating power of most seeds is not appreciably affected, provided that not too much is used nor its action continued for too long a period."

FIG. 164.—GRAIN WEEVIL.

The writer uses about one ounce of bisulphide of carbon to each barrel of grain. The infested grain is placed in barrels, and the bisulphide poured into a saucer or earthenware dish placed on the grain. The barrels are then covered with grain sacks or boards to prevent the escape of the heavy poisonous fumes which penetrate the mass.

THE ANGOUMOIS GRAIN WEEVIL.

(*Gelechia cerealella.*)

The adult is a small moth, commonly known as the Corn Weevil, and Fly moth. It is liable to infest wheat, rye, barley, oats, Indian corn, sorghum seed, and kaffir corn. Professor M. H. Beckwith, of the Delaware Experiment Station, reports the appearance of this insect, during the past year, in cow peas at the Delaware station.

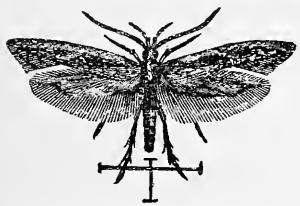


FIG. 165.—ANGOUMOIS GRAIN-MOTH.

The adult moth is brownish-yellow, or buff colored, with a satiny luster, and is about one-fourth of an inch long, with a wing expansion of about one-half inch.

"This moth," says Professor Gerald McCarthy, "is supposed to have been first introduced from France into North Carolina, where it began to give trouble as early as 1728."

The pest is most common in the mill or granary, but sometimes deposits its eggs on the grain in the field.

The eggs are laid in a patch on the tip of the grain, and hatch in from five to seven days. Professor Beckwith, in Bulletin 21, Delaware Experiment Station, says: —

"There are usually two annual broods, but in stored grain in warm buildings there are more.

FIG. 166.—GRAIN-MOTH.

"The eggs of the first brood are deposited on the grain in May or June. These hatch in about seven days. The larva burrows into the grain and continues to feed upon the interior for about twenty one days, when it is full-grown. It then eats a hole outward, leaving only a thin film of the outside of the grain, so that it may readily escape when transformed into the moth, which occurs in August. The larvæ of the

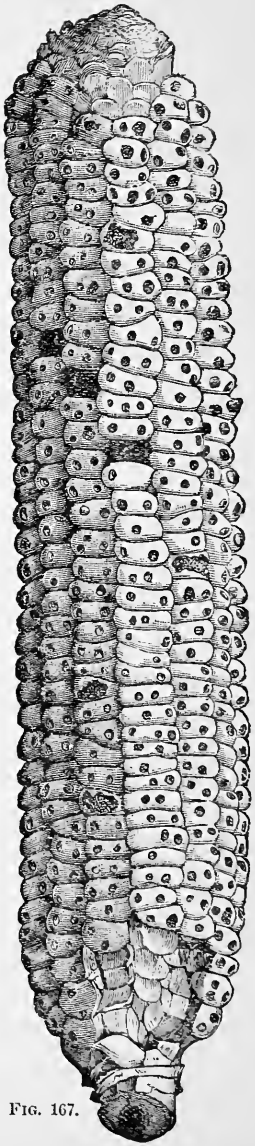


FIG. 167.

second brood remain in the larval stage during the winter, and the moths emerge in May or June." Figure 167 shows appearance of infested ear of corn. (From block kindly loaned by Delaware Experiment Station.)

Remedies.—Dr. Riley recommends the use of bisulphide of carbon. Professor Beckwith has used bisulphide of carbon, at the rate of one ounce to each 100 pounds of grain. We have found one ounce of the bisulphide sufficient for a barrel of infested grain.

What has been said about the inflammability of bisulphide of carbon, on page 48, should be ever kept in mind. It should never be used in an artificially lighted or heated room, and it should be remembered that the fumes evolved by this substance are poisonous, if breathed by man or farm animals.

THE GRAIN BEETLE.

(*Silvanus surinamensis.*)

Also known as the Saw-tooth Weevil and Grain Weevil. The mature insect is reddish-brown and averages a little over one-tenth of an inch in length. The larvæ are yellowish white, have six legs and are very active until entering upon the pupa stage which is passed concealed in the holes of partially eaten kernels or cracks of the floor or walls, or in the crevices of grain bins.

FIG. 168.—GRAIN BEETLE, ENLARGED.

Remedies.—Bisulphide of carbon is the best remedy and should be used as for other insects infesting stored grain. Professor Beckwith (Bull. 21, Delaware Experimental Station) says:

"We find that it is not necessary to place the grain to be treated in an air-tight bin or other receptacle. Of course in such a receptacle the treatment is more thorough, as the fumes remain in the grain for a longer time than when exposed to the air. We have secured satisfactory results by sprinkling the liquid over the surface of the grain in the ordinary bins as found in the farmer's granary, and then covering with blankets or other similar material."

THE RICE WEEVIL.

(*Calandra oryzæ.*)

This pest, also known as the Black Weevil, infests many varieties of grain but is, perhaps, more usually found in rice, from which fact the insect derives its more common name.

It bears a striking resemblance to the Grain Weevil but has upon

the covers of the wing cases four reddish-brown or light brownish spots.

In life history the two species much resemble each other.

Remedies.—Bisulphide of carbon as for the Grain Beetle.

THE BEAN WEEVIL.

(*Bruchus obstectus.*)

This is a native species very widely distributed over the United States. The general color of the adult is tawny gray or brownish, with dull yellow markings. The female deposits her eggs on or within the pods, and the grubs on hatching penetrate the growing beans. When confined among dry beans the eggs are laid upon the outside of the beans, and the larvæ on hatching, burrow into the contents, where all the transformations take place. The germ is seldom injured except in cases where many of the larvæ are present; the bean will then usually grow but in most cases does not produce a vigorous plant. The larvæ pupate in the fall and a few emerge as adult beetles in the autumn while the majority do not complete their transformations until the following spring.

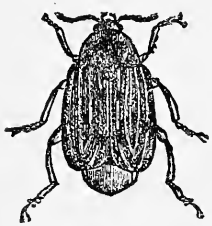


FIG. 169.—BEAN WEEVIL, ENLARGED.

Remedies.—If the seed is tied up tightly in strong paper bags, and not planted until the second year the emerging beetles cannot escape and will die.

But a better plan is to plant sound seed altogether. To kill the larvæ in infested beans, place the seed in closed vessels into which introduce bisulphide of carbon. Remember that care must be exercised in using this volatile and very inflammable substance for killing insects. A tight wooden box or barrel will answer well for this purpose, but when in use all lamps and fires should be extinguished.

Bisulphide of carbon is extremely explosive but there is no danger in using it with ordinary precaution. Benzine or gasoline will answer for the same purpose but bisulphide of carbon is generally used. It should be poured into a saucer or other shallow earthenware vessel, set on top of the seed to be treated and the top of the receptacle covered tightly. The gas evolved is very heavy and the fumes will penetrate through the seed to the bottom of the box or barrel.

The growing larvæ may also be killed by heating the beans as soon as gathered to 145° Fahrenheit.

THE PEA WEEVIL.

(*Bruchus pisi.*)

The adult is a rusty blackish-colored beetle with white markings on the wing covers and with a white spot on the hinder part of the thorax. In habits and life history this insect closely resembles the Bean weevil.

The beetles appear when the peas are in blossom, the females depositing their eggs on the young pods as soon as they begin to form. The grubs, which soon hatch, are of a deep yellow color with black heads. They burrow into the pods and enter the growing peas.

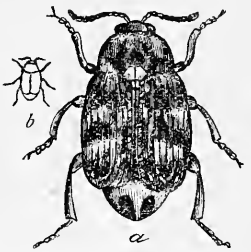


FIG. 170.—PEA WEEVIL.
a. Enlarged. *b*. Natural size.

When full-grown the grubs eat a circular hole into the shell and then complete their transformation. Like the Bean weevil, a few beetles emerge in the fall, but the greater number transform in the following spring.

Remedies.—Remedial treatment, the same as for the Bean Weevil.

MISCELLANEOUS.

TUSSOCK MOTHS.

Three species of Tussock moths have been described by entomologists as occurring in the United States.

The first is a native species known as the White-marked Tussock Moth (*Orgyia leucostigma*), which together with the other species is thus described by Dr. Chas. H. Fernald in Bulletin, No. 20, Hatch Experiment Station.

"White-marked Tussock Moth (*Orgyia leucostigma*, A. and S.). This insect is a native of this country, and was figured and described by Abbot and Smith in 1797. Since that time it has received the attention of nearly all of our entomologists.

"The eggs of this species, laid on the cocoon of a female attached to a twig of a tulip-tree, was brought to the Insectary, April 22, 1891. They were arranged in an irregular cluster containing about 225 in number and were covered by a white, glistening, frothy substance. The eggs are globular with a slight depression on the top, about one twenty-fifth of an inch in diameter and are yellowish white with a pale brown spot on the top and a ring of the same color around it.

"The male expands about an inch and a quarter, and is of a dull ashy gray color with several wavy, dark brown lines crossing the fore wings which are whitish along the front edge with a small black spot near the apex and a small white spot near the anal angle. The antennae are heavily fringed. The females are lighter gray than the males and have no wings, only the rudiments of them being visible. The body is oval in outline and quite plump before the eggs are laid.

"These eggs hatched May 10th, and the caterpillars passed their molts (the description of which is omitted here) and reached maturity June 15th. The full-grown caterpillars (Fig. 171) are about an inch and an eighth in length, of a bright yellow color, sparingly clothed with long, fine, yellow hairs on the sides of the body, and having four short, thick, bush-like, yellowish tufts on the top of the fifth and the three following segments, two long, black plumes or pencils extending forward from the sides of the second segment, and a single plume on the top of the twelfth segment. The head and top of the second segment and also two retractile tubercles on the top of the tenth and eleventh segments are bright red; there is a narrow black or brownish stripe along the top of the back and a wider dusky stripe on each side of the body.

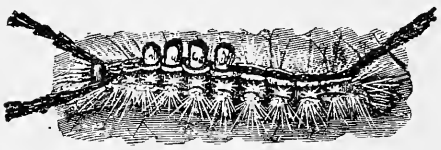


FIG. 171.—WHITE MARKED TUSSOCK MOTH. FULL-GROWN CATERPILLAR.

"On June 15, they commenced spinning their cocoons and the moths emerged June 21st. After mating, the females laid their eggs on the old cocoons which they usually attach to a leaf adhering to a branch of the tree. These eggs of the second generation hatched July 8, passed their transformations and pupated August 10. The moths of this brood emerged August 23, and laid their eggs which remained through the winter and hatched the next spring, thus giving two generations a year in this state.

"This species feeds on the leaves of nearly all deciduous trees, and fir, spruce, larch and cypress.

"The second species is called the Willow Tussock Moth (*Orgyia definita*, Pack) and was for a long time confounded with the preceding species with which the male and female moths agree very closely, but there are marked differences in the other stages.

"The eggs are laid in the fall in clusters on the old cocoon adhering

to the branches of trees, and covered with hair from the abdomen of the female, which enables one to distinguish them from the white, froth-covered eggs of the white-marked Tussock moth or the naked eggs of the following species.

"The full-grown caterpillar has the head and body pale yellow with an almost colorless stripe along the middle of the back. This stripe is narrow, and greenish on the third and fourth segments, widening and enclosing the yellow, dorsal, brush-like tufts on the fifth, sixth, seventh and eighth segments, narrowing on the ninth, tenth, eleventh and twelfth segments, enclosing the two retractile tubercles, and is absent on the last segment. There is a narrow subdorsal and a fainter stigmatal band. These bands vary in color from dark brown to black, and there is a velvety-black spot between the tufts on the top of the sixth, seventh and eighth segments. The tubercles are all pale yellow, and a long pencil of black hairs inclining forward arises from each side of the second segment, while a similar one of light brown and black hair inclines backward from the top of the twelfth segment. The other hair is long, thin and white.

"This species feeds on the leaves of the willow, oak, maple and many other trees."

The third species of Tussock Moth is the common European (*Orgyia antiqua*, Linn). This species has long been known in this country, but was supposed to be distinct, and was described by Dr. Fitch as the modern vaporer moth (*Orgyia nova*), and again by Mr. Henry Edwards, from California specimens, as *Orgyia badia.*

"The female is ringless like the other species, and lays her eggs without any covering on the old cocoon which is fastened to the branch of a tree. A cluster of these eggs was received from Fitchburg, Mass., April 14, 1891, on a branch of quince, and began to hatch April 22. The caterpillars reached their full growth and began to spin cocoons June 15. The first moths emerged June 25, and eggs were laid July 5th, which hatched on the 15th, but the caterpillars died before reaching maturity. Whether there are more than two broods in the state (Massachusetts), I am unable to say." * * * * * *

This insect is said to feed in Europe on plum, apple, mountain ash, rose, apricot, raspberry, bilberry, heath, horn-beam, hazelnut, alder, willow, beech, birch, oak, pine, and many other plants.

In this country it has been found feeding on the leaves of the rose, plum, apple, quince, thorn, aspen and birch.

Remedies.—As these three Tussock moths are so similar in their general habits they may be dealt with alike. They all pass the winter

in the egg stage on the old cocoons fastened to the branches of the trees, and are easily seen during the fall, winter, and spring while the trees are bare, when they may be removed and destroyed. If, however, they have been neglected and allowed to hatch, the caterpillars may be destroyed by spraying the trees with Paris green in water in the proportion of one pound of the poison to from 150 to 200 gallons of water.

THE ROSE SLUG.

(*Selandria rosæ.*)

The larva is a dull, yellowish worm, which, when full grown, is a little over one-third of an inch long. It is found during the day on the under side of rose leaves, about the time the buds are unfolding. The leaves of infested bushes turn brown, and if the work of the slugs is not interrupted, the plants are soon entirely denuded of leaves. The slugs feed at night, or on cloudy days, gnawing away the soft substance of the upper side of the leaves, and leaving a mere skeleton of veins. The larval period covers about two weeks, although individual slugs are found on the leaves for about one month. When full-grown the slugs leave the rose bushes and retire to the ground, where they construct small earthen cells, in which they hibernate until spring. The adult is a four-winged fly, of the same family as the currant worm fly.

Remedies.—Good pyrethrum or buhach is effective, applied to the leaves when damp, by means of a powder-gun. Whale oil soap-suds, made in the proportion of one-half pound of soap to five gallons of water, will surely destroy the slugs, but the odor of this insecticide is objectionable, and discoloration of the opening buds may result from copious applications of the remedy.

A pail full of water to which is added two tablespoonfuls of powdered white hellebore, sprinkled over the bushes, effectually destroys the slugs without injury to the flowers.

Professor Garman (in Bulletin No. 40, Kentucky Experiment Station) says :—

"At the experiment farm at Lexington we have used London purple and Paris green for two seasons, and last season the slugs did not appear on the treated bushes at all. The poisons were applied in the strength used for apple trees (1 pound to 200 gallons of water). It must be remembered, though, that such materials cannot be applied to bushes after the buds unfold without destroying the petals. The other insecticides mentioned may be used more freely."

THE ROSE LEAF-HOPPER.

(*Typhlocyba rosæ.*)

This is an old offender, readily recognized by its yellowish-white body, and white, semi-transparent wing covers. It is found on the under side of the rose leaves, where it sucks out the substance of the plant, causing on the upper surface a white, spotted appearance. There are several broods each season.

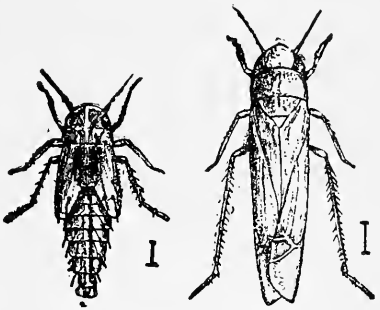


FIG. 172.—ROSE LEAF-HOPPER. (*Weed.*)

Remedies.—Spray infested plants with a decoction of pyrethrum, tobacco, or kerosene emulsion. Pyrethrum or tobacco in fine powder may also be dusted over the plants.

MEALY-BUGS.

(*Dactylopius destructor and D. adonidum.*)

These two species of mealy-bugs are the commonest and most troublesome in greenhouses. The name is derived from the yellowish-white secretion, resembling meal or flour, which the insects throw off from minute pores along the sides of their bodies.

Remedies.—Carefully rub off with the hand or a brush, all the insects that readily yield to this treatment, and then spray the affected parts of plants with kerosene emulsion.

Professor Comstock has destroyed mealy-bugs by dusting the wet plants with a mixture made by grinding in a mortar equal parts of smoking-tobacco and flowers of sulphur.

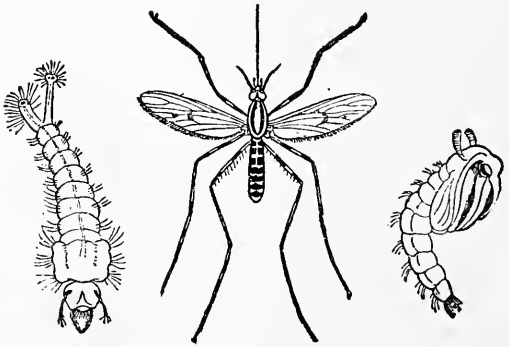
THE RED SPIDER.

(*Tetranychus telarius.*)

This pest, so common in the greenhouse, is found on the under leaf surfaces of plants. Here it spins a very fine silken web as a protection from its enemies, while it proceeds to suck the life-juices out of plants and to bring forth an innumerable and voracious progeny. These red-

dish mites are commonly known as Red Spiders and are distantly related to common spiders, having, like them, four pair of legs in the adult stage. The young have three pair of legs, and are often so small as to be scarcely visible to the naked eye.

Remedies.—This insect is rarely troublesome in greenhouses where the air is kept saturated with moisture and the plants are well supplied with water. Wherever the pest appears plants should be sprayed with kerosene emulsion, tobacco decoction, or should be dusted with very fine tobacco dust.



PART V.

INSECTS THAT INFEST DOMESTIC ANIMALS.

THE OX WARBLE FLY, OR BOT-FLY.

(*Œstrus bovis.*)

This insect causes the boil-like swellings on the backs of cattle so often noticeable during spring and early summer. The pest belongs to the same family as the sheep and horse bot-fly. The adult is about half an inch long, with two smoky wings, and the body is covered with orange or yellowish down. The female flies deposit their eggs on the backs of cattle, and the larvæ, which are whitish or grayish maggots, burrow into the skin, where they form the cells or "warbles."

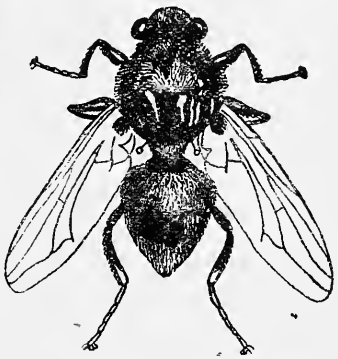


FIG. 173.—THE ADULT OX BOT-FLY ENLARGED. (*Garman.*)

The flesh is irritated by their presence, and ulceration results, distressing the animal, and injuring the hide and the quality of the beef if the beast is slain for food.

The young grubs are at first quite small, but when full-grown are about an inch long.

Remedies.—Dr. Riley says: "Smearing the backs with train or fish oil is the simplest and easiest method of destroying the warbles, which it does by closing the breathing pores on the posterior end of the body. The destruction of the larvæ in this way may be effected by one or two applications in autumn, and is the most satisfactory method of controlling the pest."

Professor H. Garman (Bulletin No. 40, Kentucky Experiment Station) says :—

"For killing the grubs in the skin we have found a mixture of lard and sulphur (one part flowers of sulphur to four parts of lard), rubbed along the back and over the openings of the tumors, completely effective. Vaseline or cosmoline, mixed with sulphur, may be used in the same way. Poisonous, or substances possessing acrid properties, should not be used, as there is danger of aggravating, instead of helping the sores."

THE SCREW WORM.

(*Compsomyia macellaria.*)

This insect is believed to occur throughout the habitable parts of North and South America.

In the southern states there are no farm animals that do not suffer more or less from its attacks. Dr. M. Francis, who has studied the habits and life history of this insect, says: "In all animals alike, the eggs, after being laid by the fly, hatch into larvæ or so-called 'worms.' The exact length of time this requires seems to vary with circumstances. My present opinion is that if the eggs are laid in a moist place and on a warm day, it requires less than one hour; whereas, if laid in a dry place, they seem to dry up and lose their vitality. The young larvæ when first hatched are small and easily overlooked.

"If they are hatched on the surface in a drop of blood from a ruptured tick, for instance, they attempt to perforate the skin, and if hatched in wounds, they at once become buried out of sight. They seem to attach themselves by their heads and burrow their way under the skin, completely devouring the soft flesh. Occasionally a few are seen moving from one place to another, but usually they remain fixed at one point. The worms grow steadily in size, and the hole in the flesh becomes larger every day. Sometimes the worms make tunnels, but not to any depth; they usually stay on the surface. They evidently produce considerable irritation, for the part is always swollen and constantly bleeding. This swollen, gaping appearance of the wounds, together with a constant discharge of blood, are characteristic of the presence of the worms. It seems to require about a week for the worms to become fully grown. At that time they are about five-eighths to six-eighths of an inch long. They then leave the sore and go into the ground where they pass the pupa state and hatch out as flies in from nine to twelve days."

Remedies.—The remedies employed by Dr. Francis for destroying the larvæ were cresylic ointment, calomel, chloroform or carbolic acid.

This insect is propagated in decaying animal and vegetable matters, and for this reason *pabulum* favorable to the development of the pest should be promptly burned or buried.

THE HORN FLY.

(*Hæmatobia serrata*)

An imported insect which has occasioned much alarm among dairymen in the states of the Atlantic seaboard and in several states west of the Alleghanies. This adult is a small, grayish fly, resembling the common house fly but smaller. The insects have the peculiar habit of settling in swarms about the bases of the horns (Fig. 174). From

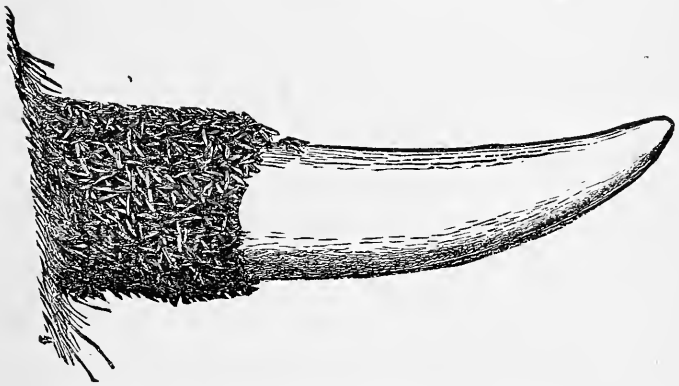


FIG. 174.—THE HORN FLY.
Band of flies about base of horn, enlarged. (*From cut kindly loaned by the Division of Entomology, U. S. Department of Agriculture.*)

this strange habit the insect has received its name. Cattle are annoyed most by this pest just behind the shoulders and along the back ; the insects insert their beaks into the skin injecting an irritating secretion which causes inflammation and a flow of blood to the irritated parts : upon this blood the insects feed. "The flies," says Professor H. Garman, "follow the cattle to the barns at night and remain with them apparently at all times, except when depositing the eggs. It has been asserted that the eggs were laid and the grubs developed at the bases of the horns. This is unquestionably not true. The eggs

are placed on fresh droppings from cattle, about barnyards and in pastures, and the grub and pupa state is passed in these. The only injury cattle suffer is, consequently, from the stings of the flies.

"The injury done to cattle has been greatly over-estimated in some instances, yet there can be no doubt that the yield of milk from cows greatly worried by horn flies is much reduced, and growing and fattening stock is doubtless retarded by their attacks." (Bulletin No. 40, March, 1892, Kentucky Experiment Station.)

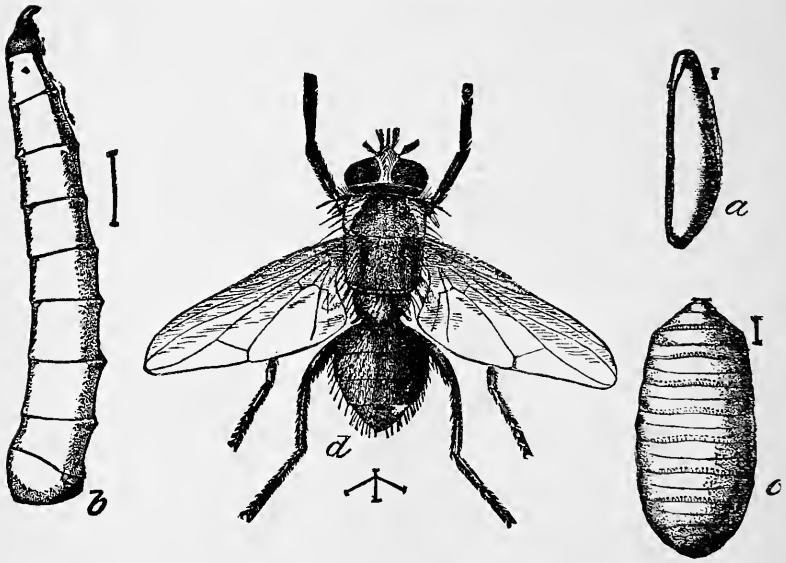


FIG. 175.—THE HORN FLY.

a. Egg. *b*. Larva. *c*. Puparium. *d*. Adult fly. The lines show the natural size, enlarged. (*From cut kindly loaned by officers of the Division of Entomology, U. S. Department of Agriculture.*)

Remedies.—Professor Garman in the same Bulletin gives the following remedial treatment:—

"The best insecticide we have used for the purpose is the powder known as buhach, manufactured by G. N. Milco, of Stockton, California. A heaping tablespoonful of this, taken in the hand and rubbed about the bases of the horns and in the fur along the back, will rid a cow of the flies in a few minutes. The powder seems to retain its

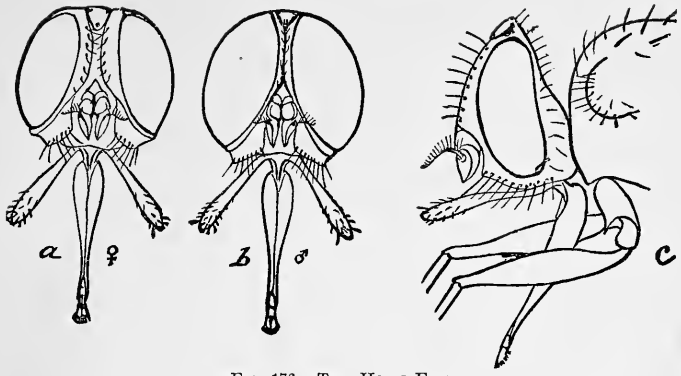


FIG. 176.—THE HORN FLY.

a. Showing front of head and mouth parts of female. *b*. Showing same of male. *c*. Side view of head and front division of body, enlarged. (*From cut kindly loaned by Division of Entomology, U. S. Department of Agriculture.*)

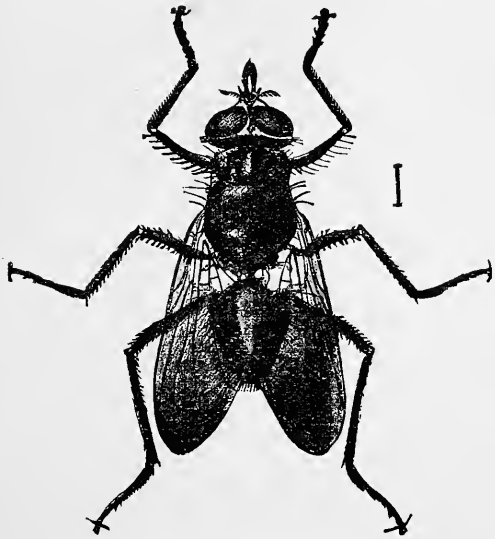


FIG. 177.—THE HORN FLY.

Showing fly with folded wings, enlarged. (*From cut loaned by Division of Entomology, U. S. Department of Agriculture.*)

effectiveness for some time, and cattle treated with it are not much troubled with the flies for a day at least afterward. It loses its properties as an insecticide, however, when exposed, and must, consequently, be applied frequently.

"Finely powdered tobacco proves to be almost equally effective with buhach, and when obtainable is to be preferred because of its greater cheapness.

"Train oil has also been tried, and has proved useful. It does not kill the flies as does the buhach, but is more lasting than either buhach or tobacco dust. It has the further advantage in that it can be applied to the legs, thus driving away the common flies which attack these. It has been applied by soaking a piece of cloth with it, and then giving the parts attacked a thorough rubbing with the oiled cloth.

"For dairy cattle I would apply a little buhach or tobacco dust to the horns and back each morning before the cows go to pasture, and supplement this by rubbing the legs occasionally with the oiled cloth.

"The Persian insect powder (pyrethrum) of drug stores will doubtless answer the same purpose as buhach, provided it is fresh."

The larvæ are said to be readily destroyed by mixing land plaster with the manure or by spreading out the droppings to dry.

CATTLE AND HORSE LICE.

There are several species of lice infesting cattle and horses, all of which resemble each other more or less in habits and life history.

THE SHORT-NOSED OX-LOUSE (*Hæmatopinus eurysternus*) is provided with little hooks for attaching itself to the skin, and within the hooks is the sucking tube through which it imbibes the blood of infested animals. This insect is usually found on the neck and shoulders of cattle.

Professor Herbert Osborn, in Bulletin No. 7, Division of Entomology, United States Department of Agriculture, thus describes this species :—

"The general color of the head and thorax is a light brown, approaching yellowish, with touches of bright chestnut on the head and legs and margin of the thorax, also touches of dark brown on these parts, more particularly on the dorsal portions of the thorax. The abdomen in fresh specimens has a general bluish aspect, not so noticeable in preserved specimens, besides its color depends evidently in large degree upon its contents."

Remedies.—"This," continues Professor Osborn, "is one of the most difficult parasites to destroy, and once settled upon an animal

should receive prompt and thorough treatment. The main reliance of veterinarians seems to be stavesacre, and this can doubtless be depended upon to accomplish the desired end. Mr. Tanney recommends the seed of common larkspur steeped, and the animal washed with the liquor. * * * * * Of course this and the stavesacre are nearly identical, both plants belonging to the genus *Delphinium*. Washes of carbolic acid soap or of tobacco infusion are also effectual, but washes of any kind are but illy adapted to use in mid-winter, the time when there is frequently most necessity for treatment.

"Mercural ointment, sulphur, or tobacco smoke, kerosene and lard, or

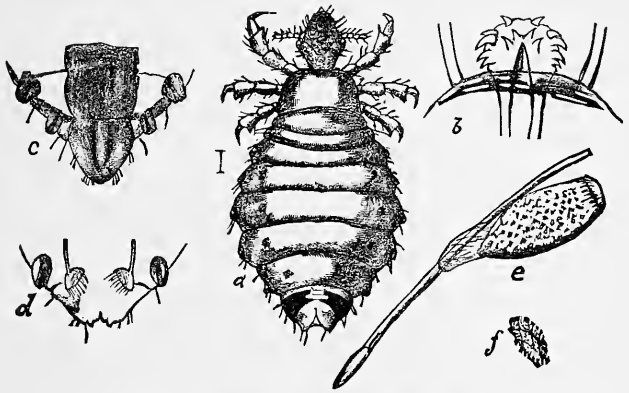


FIG. 178.—SHORT-NOSED OX-LOUSE. (*Osborn.*)

a. Female. *b*. Rostrum. c. Ventral surface last segments of male. *d*. Female. *e*. Egg. *f*. Surface of egg greatly enlarged. (*Kindly loaned by the Division of Entomology, U. S. Department of Agriculture.*)

kerosene emulsion, road dust, ashes, etc., may be resorted to, according to the circumstances. Infested animals should, if possible, be placed apart from the others, and much trouble may be saved by this precaution."

THE LONG-NOSED OX-LOUSE (*Hæmatopinus vituli*) and the BITING OX-LOUSE (*Trichodectes scalaris*), are other species. The eggs are glued to the hair of infested animals and the young differ little from the adults, except in size.

The species infesting horses are the *Sucking Horse-louse* (*H. asini*), the Rarer Biting Horse-louse (*Trichodectes pilosus*), and the common *Biting Horse-louse* (*T. parumpilosus*). The latter is the most annoying

and common of these species, and usually infests animals kept at pasture. The mane, head, and tail, are the parts most liable to be infested,

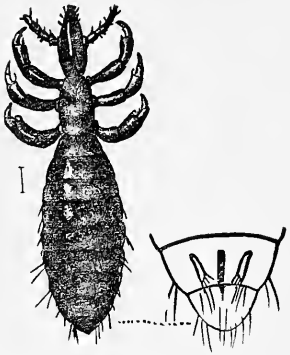


FIG. 179.—LONG-NOSED OX-LOUSE. Under surface of last segments of female, showing brush-like organs. (*Osborn.*)

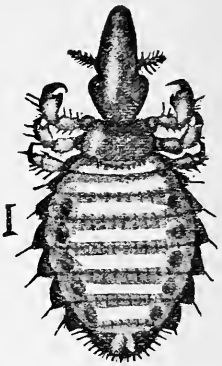


FIG. 180.—SUCKING HORSE-LOUSE. (*Comstock.*)

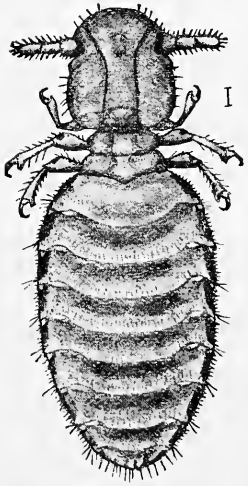


FIG. 181.—BITING HORSE-LOUSE. (*Osborn.*)

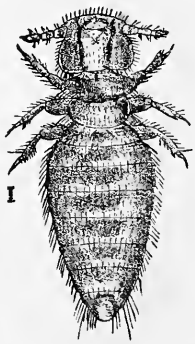


FIG. 182.—BITING HORSE-LOUSE. (*Osborn.*)

Remedies.—Kerosene emulsion, diluted with from eight to nine parts of water, is the best insecticide for destroying these pests and all other lice infesting domestic animals. It may be applied with a force pump and spraying nozzle or rubbed in with the fingers or a brush. Other remedies are a wash of carbolic acid, or a decoction of tobacco ($\frac{1}{2}$ lb. of tobacco to one gallon of boiling water).

(*The above cuts were kindly loaned by the Division of Entomology, U. S. Department of Agriculture.*)

INSECTS OF THE HOUSEHOLD.

ANTS.

The species most generally infesting houses is the little red ant (*Monomorium pharaonis*), believed to be a native of Europe.

Remedies.—The nests of this troublesome and ever active little pest are made under floors, between walls or in walks or lawns about the house. When once located the insects are readily destroyed with boiling water, benzine, or kerosene emulsion. To kill the larger ants that infest lawns and grass plots, Dr. Riley suggests the use of bisulphide of carbon. Holes are punched into the nest and a teaspoonful of bisulphide of carbon is then poured down each hole and the nest covered with a damp blanket. The blanket is then removed and the bisulphide of carbon exploded at the mouth of each hole by means of a lighted candle or torch at the end of a long pole. The poisonous fumes are driven through the underground passages of the nest, killing the insects in vast numbers.

THE BED-BUG.

(*Acanthia lectularia.*)

We presume this pest to be sufficiently well-known to need no description here.

Our readers who have never had the acquaintance ship of this insect thrust upon them will readily recognize it from the illustration; while those to whom its blood-thirsty propensities are already known would find nothing edifying in the study of its habits and life history.

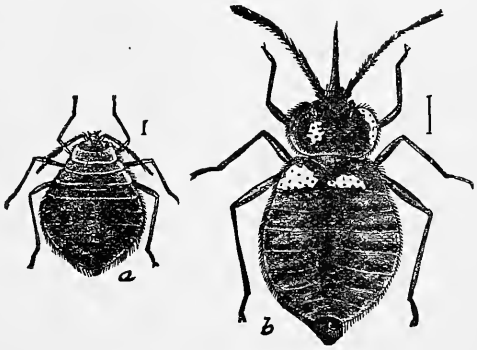


FIG. 183.—BED-BUG.
a. Young *b*. Adult. Magnified (*Riley.*)

Remedies.—Spraying the cracks of beds and walls with benzine

destroys both the eggs and the insects. A weak solution of sulphuric acid sprinkled into joints and holes infested with bed-bugs is also said to kill them.

CLOTHES-MOTHS.

Three nearly related species are common in the United States.

The Case-making Clothes-moth (*Tinea pelleonella*) is probably the commonest. It is thus described by Dr. Riley: "The small light-brown moths, distinguished by the darker spots at intervals on the wings begin to appear in May and are occasionally seen flitting about as late as August.

"They pair and the female then searches for suitable places for the deposition of her eggs, working her way into dark corners and deep into the folds of garments, apparently choosing by instinct the least conspicuous places. From their eggs hatch the soft, white-bodied larvæ, each one of which begins immediately to make a case for itself from the fragments of the cloth upon which it feeds. The case is in the shape of a hollow roll or cylinder and the interior is lined with silk. As they grow they enlarge these cases by adding material to either end and by inserting gores down the sides which they slit open for the purpose. The larvæ reaches its full growth toward winter and then crawling into some yet more protected spot, remains there torpid through the winter within its case, which is at this time thickened and fastened at either end with silk. The transformation to pupa takes place within the case the following spring, and the moths soon afterward issue.

"The larva feeds in all woolen cloths, and also in hair-cloth, furs, and feathers."

Remedies.—Dr. Riley, in *Insect Life*, says: "During the latter part of May, or early in June, a vigorous campaign should be entered upon. All carpets, clothes, cloth-covered furniture, furs, and rugs, should be thoroughly shaken and aired, and, if possible, exposed to the sunlight as long as practicable. If the house is badly infested, or if any particular article is supposed to be badly infested, a free use of benzine, in the manner mentioned in my last article, will be advisable. All floor cracks and dark closets should be sprayed with this substance.

"Too much pains cannot be taken to destroy every moth and every egg, and every newly-hatched larva, for immunity for the rest of the year depends largely—almost entirely—upon the thoroughness with which the work of extermination is carried on at this time. The ben-

zine spray will kill the insects in every stage, and it is one of the few substances which will destroy the eggs. I would, however, repeat the caution as to its inflammability. No light should be brought into a room in which it has been used until after a thorough airing, and until the odor is almost dissipated.

"The proper packing away of furs and winter clothing through the summer is a serious matter. A great deal of unnecessary expenditure in the way of cedar chests and cedar wardrobes and various compounds in the way of powders has been urged by writers on these pests. But experience fully proves that after a thorough treatment in May or June, garments may be safely put away for the rest of the season, with no other protection than wrapping them closely in stout paper, to preclude infection through some belated female. My assistant, Mr. L. O. Howard, tells me of an excellent plan, which he has adopted. He buys for a small sum from his tailor a number of pasteboard boxes in which they deliver suits, and his wife carefully folds and packs away all clothing, gumming a strip of wrapping paper around the edges of the cover, so as to leave no crack. These boxes will last for a life-time with careful use. Others use for the same purpose ordinary paper flour sacks or linen pillow cases, which answer well. The success of these means depends entirely on the thoroughness of the preliminary work. Camphor, tobacco, naphthalene, and other strong odorants are only partial repellants and without the precaution urged are of little avail.

"Cloth-covered furniture which is in constant use will not be harmed, and the same may be said of cloth-lined carriages. Where such furniture is stored away or kept unused in a dark room, or where the carriages are left in a dark coach-house through the summer, at least two sprayings with benzine, say once in June and once about August first, will be advisable. Another plan which will act as protection in such cases is to sponge the cloth linings and cover both sides, where possible, with a dilute solution of corrosive sublimate in alcohol, made just strong enough not to leave a white mark on a black feather."

Blotting paper soaked in a mixture of equal parts of oil of camphor and spirits of turpentine and laid among clothes or furs is also said to destroy moths.

COCKROACHES.

Three species, the ORIENTAL COCKROACH (*Periplaneta orientalis*), the GERMAN COCKROACH or Croton Bug (*Phyllodromia germanica*), and the AMERICAN COCKROACH (*Periplaneta americana*), are common throughout this country. The imported species live about dwellings. The American is usually found in woods and fields but occasionally takes up its abode in dwelling-houses.

Remedies.—Dr. Riley recommends the following method for destroying this troublesome pest: "Just before nightfall go into the infested rooms and puff buhach into all crevices, under base-boards, into drawers and cracks of old furniture, in fact wherever there is a crack, and in the morning the floor will be covered with dead and dying or demoralized and paralyzed roaches, which may easily be swept up or otherwise collected and burned. With cleanliness and persistency in these methods the pest may be substantially driven out of a house and should never be allowed to get full possession by immigrants from without."

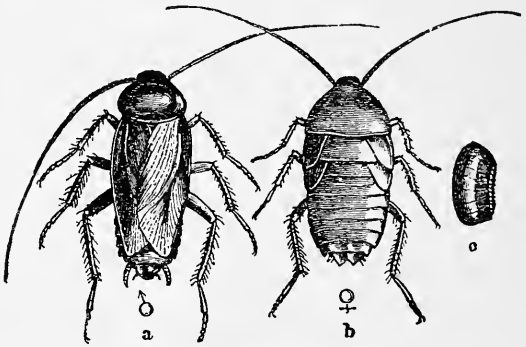


FIG. 184.—COCKROACHES.
a. Winged male. *b*. Unwinged female. *c*. Egg-mass.

THE HOUSE FLY.

(*Musca domestica.*)

We wish to call attention to a very simple and effective method of destroying house flies. At night, when the house is closed, a tablespoonful or more of Persian insect powder, or of buhach, is puffed from a powder bellows through the room toward the ceiling, after

which the doors should be quickly closed for the night. In the morning the flies will be found dead or stupefied, when they may be swept up and burned. Cover with linen or newspapers any objects in which the flies are liable to fall.

THE BUFFALO CARPET BEETLE.

(*Anthrenus scrophulariæ.*)

It is in the larval stage that the injury is done by this insect. The adult beetle is black, or nearly so, with white spots, and a reddish stripe along the middle of the back, and is about one-fourth of an inch long.

This pest is said to have been introduced into the United States from Europe in the Centennial year (1876), and is now quite common, and very destructive, in many of the New England and other States.

Remedies.—Dr. Riley says: "At house-cleaning time as many of the rooms should be bared at once as possible, and the housekeeper should go carefully over the rooms, removing all dust, and, with a hand atomizer, charged with benzine, should puff the liquid into all the floor cracks, and under the base-boards, until every crevice has been reached. The carpets themselves, after thorough beating, should be slightly sprayed with the same substance, which will quickly evaporate, leaving no odor after a short time. The inflammability of benzine, however, should be remembered, and no light should be brought near it."

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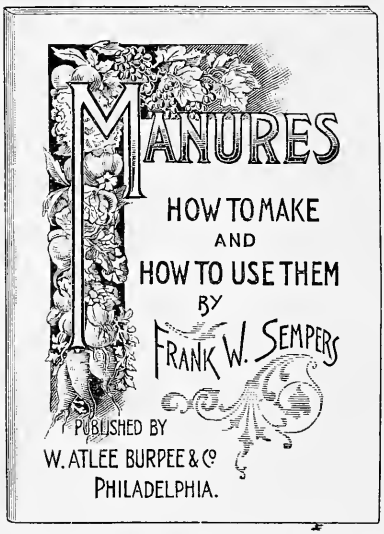

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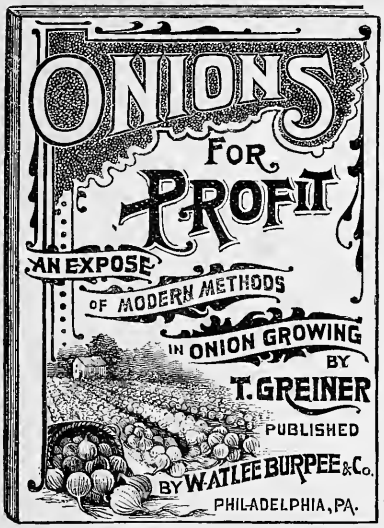

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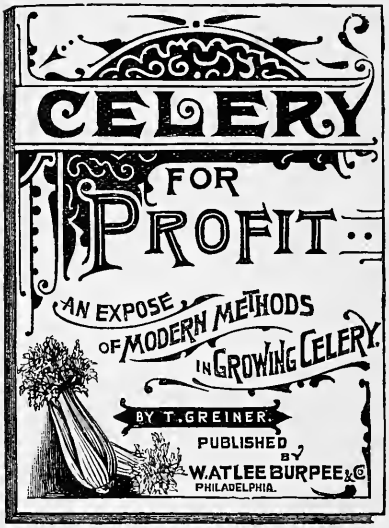

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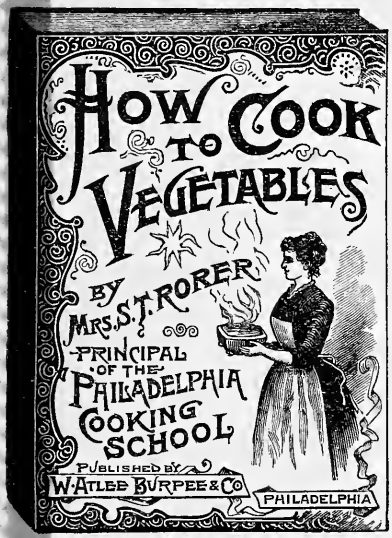

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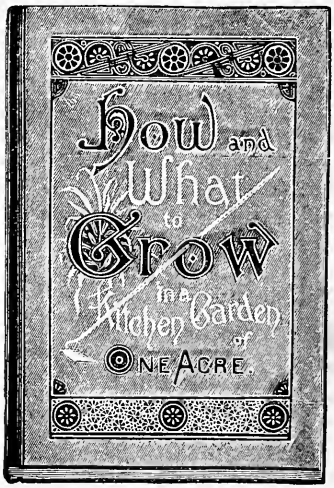

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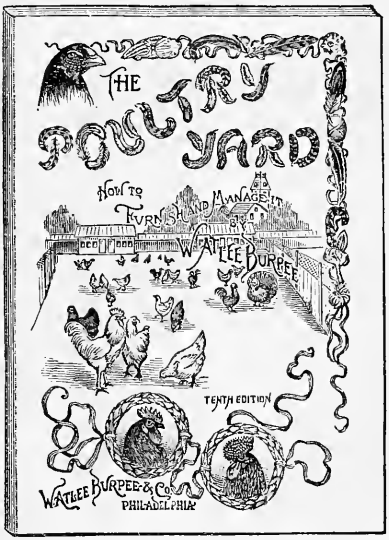

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